Vol. XLVIII

TABLE OF CONTENTS.

No. 25

(20 pages and Engineering Literature Supplement.)

Page.

ENGINEERING NEWS OF THE WEEK 513

LEADING ARTICLES:

High-Pressure Pumping Plant and Force Main for the Water-Works of Prescott, Arizona (illustrated) ..... W. W. Follett, M. Am. Soc. C. E. 514

Flywheel Capacity for Engine-Driven Alternators (illustrated) ..... Walter I. Slichter, Jun. M. Am. Soc. M. E. 515

Notes on Water Consumption and the Use of Meters (illustrated) 517

Methods of Work on the Atlantic Avenue Improvement of the Long Island R. R. (illustrated) 518

The Relation of the Architect and Engineer in the Design and Construction of Government Buildings ..... Captain John Stephen Sewell. 520

Some Low Freight Rates for Water Shipments 521

Modern Crane Practice in a Locomotive Repair Shop (illustrated) 524

High-Pressure Steam-Piping 525

A Wrecked Wooden Water Tank and a New Steel Stand-Pipe at Madison, Neb. (illustrated) ..... Arnold C. Koenig, M. Am. Soc. C. E. 526

Annual Meeting of the American Institute of Architects 526

Address of the President of the Institution of Civil Engineers 527

A New Railway Block Signal System (illustrated) 527

Proposed Rules to Govern the Storage and Use of Explosives in New York City (illustrated) 530

Self-Cleaning and Cinder-Catching Smokeboxes on Locomotives (illustrated) 531

EDITORIAL COMMENT.—Our Engineering Literature Supplement—The Coroner's Jury Verdict on the Boiler Explosion at the Swift Packing Company's Works—The "Sudden Valve Opening" Theory of Boiler Explosions—The Inherent Dangers of the Externally-Fired Shell Boiler—More Trouble with Ice on the Third Rail on New York Elevated Railways—Failures of Wooden Water Tanks—The Miller Block Signaling System—A World's Congress of Engineers and Engineering Societies in 1904 ..... 522, 523

EDITORIAL.—Should Dynamite be Used in Cities? 523

LETTERS TO THE EDITOR.—The Discussion on the Metric System Before the American Society of Mechanical Engineers: Gus. C. Henning—Introducing Metric Nomenclature: M. Am. Soc. M. E.—Other Methods of Joining Two Curves with a Tangent (illustrated): E. H. Beckler, M. Am. Soc. C. E., and B. C. Yates—Notes and Queries 524

THE COMPLETION OF THE NILE DAM at Assouan was celebrated on Dec. 10, less than four years after the laying of the first stone. Descriptions of this great structure were published in Engineering News of Sept. 26, 1901, May 8, and Aug. 14, 1902.

THE AMERICAN PACIFIC SUBMARINE CABLE was landed at Honolulu on Dec. 14, and a message was sent from that place to President Roosevelt by Clarence H. Mackay, President of the Pacific Commercial Cable Co., announcing the event.

AN APPROPRIATION OF $100,000 for the investigation of the water supply of New York has been authorized, with the understanding that $36,000 will be paid the three engineers recently appointed to make the investigation, and that $64,000 will be available for assistance outside that rendered by the Department of Water Supply, Gas and Electricity. The new commission is expected to begin work at once and to submit its final report by Nov. 15, 1903. The studies of consumption and waste are to be carried on largely by the regular water-works department of the city, which has already arranged for measuring the flow of water in different districts by means of pitometers. The engineer-commissioners are Prof. Wm. H. Burr, Rudolph Hering, and John R. Freeman, Members Am. Soc. C. E.

IMPROVEMENTS TO THE WATER SUPPLY for fire protection in the Borough of Brooklyn, and an advance in insurance rates, have been recommended by the New York Fire Insurance Exchange Committee on Minimum Rates and District Charges. Among the improvements urged are the substitution of larger mains for small and rust-filled pipe; more hydrants and high-pressure standpipes; an auxiliary salt water system, and a large addition to the general supply.

MUNICIPAL OWNERSHIP OF WATER-WORKS at Memphis, Tenn., is said to be assured by a recent vote of the stockholders of the Artesian Water Co. to accept the city's offer to buy the works.

BIDS FOR 15,000 WATER METERS, of ⅝-in. size, are wanted at Cleveland, O., until Dec. 27. Mr. Chas. P. Salen is Director of Public Works, and Mr. E. W. Bemis is Superintendent of Water-Works.

AN ELECTROLYSIS PREVENTION ORDINANCE was passed by the city council of Atlantic City, N. J., on Nov. 24. It gives owners of existing street railways until Feb. 1, 1903, to "take adequate measures to completely prevent injury to water mains, service pipes and other metallic structures on account of electrolysis." The city does not attempt to say how this shall be done, further than to prohibit bonding to water mains or other conductors not expressly provided for the purpose and to stipulate that "a complete metallic circuit" must be furnished and insulated. The maximum allowable difference of potential between the special metallic return circuit and any pipe or other metal conductor not intended to be a part of the return, and also between any two points on the special return within a distance of 200 ft. of each other, shall not exceed ¼-volt, and no current on a water pipe or other metallic circuit other than that pertaining to the street railway service shall exceed one ampere. The ordinance provides for tests in February and August of each year to determine whether or not there are stray electric currents and it also provides for filing plans showing the methods proposed to control the return current. Damages due to electrolysis, including the cost of discovery and repair, are to be charged to the street railway and a penalty is provided for violation of or failure to comply with the ordinance. We are indebted for the foregoing information to Mr. Kenneth Allen, M. Am. Soc. C. E., Engineer and Superintendent of the Atlantic City Water-Works.

THE NEW POWER STATION of the Union Electric Light & Power Co., of St. Louis, will have a generating capacity of 12,000 KW., and will be equipped with Allis-Chalmers vertical cross-compound engines and Westinghouse generators. The building is located on the river bank, and in fact extends out into the river. The foundations will be of concrete carried down to solid rock, and the outer or river wall will be very heavy, reinforced by steel frames. A peculiar feature of the construction is that owing to the depth of the rock, the boiler-room floor will be below the ordinary water level of the river, and special care must be taken to make the river wall watertight. This part of the work will be built in a steel caisson formed of steel piles 35 to 50 ft. long. Each pile is a steel channel, alternate piles having a Z-bar riveted along each side, so that the piles interlock. The other channels have angles riveted near each flange to form grooves which may be calked with oakum to render the caisson watertight. The interior struts will be steel channels with bearing plates riveted against the ends, these plates being at an angle, to allow of driving oak wedges between the struts and the sides of the caisson. Material is handled by a cableway about 350 ft. long, parallel with the river bank. The building will be of steel frame construction with buff pressed brick walls. Mr. Joseph Walsh is President of the company; Mr. Charles H. Ledlie, General Manager, and Mr. W. S. Ludington, Resident Engineer. The company already has a power station in operation at Tenth and St. Charles Sts.

AN ELECTRIC RAILWAY TO THE SUMMIT of Mont Blanc is planned and is before the French Minister of the Interior for approval. The line would commence at the village of Houches, on the Savoy side, and the whole line will be about 11 miles long. The originator of this scheme is a French engineer named Fabre.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Atchison, Topeka & Santa Fe Ry. at Rothville, Mo., on Dec. 8. A through limited passenger train was wrecked at a switch, which moved under the train after the engine had passed over it. The train was almost demolished, but only two persons, the engineer and fireman, were killed, and one, a passenger, injured.

A GAS EXPLOSION in the Cleveland Water-Works tunnel killed three men and injured a number of others on the afternoon of Sunday, Dec. 14. It appears that the tunnel, or two sections of it, had been completed, except for cleaning up, and that the air pressure had been taken off. It is thought that fire damp found its way in through the lining, but how it was exploded is unknown. Mr. T. H. Murphy, Superintending Engineer, was in the tunnel at the time, but not where the effect of the explosion was most marked. He was, however, thrown down and stunned. This is one of a long series of accidents to the tunnel, shafts and cribs, which have cost some 60 lives altogether.

A RAILWAY TO THE COPPER MINES OF PERU is said to be certain of construction. Mr. James B. Haggin, formerly part owner of the great Anaconda copper mine, represents a syndicate which is said to have paid $3,000,000 for the Cerro de Pasco copper mines. This syndicate has a contract with the Peruvian Government to build a railway from the head waters of the Amazon across the Andes, through a pass of 7,170 ft. elevation, to the Pacific coast. They are at present building a railway to the copper mines where, it is said, they purpose expending some $7,000,000 in development work and smelters. The agricultural and mineral resources of this district are reported to be wonderful; and the building of the Panama Canal is certain to bring both men and capital into what is now an almost unexplored country.

THE CHICAGO BOILER EXPLOSION, noted in our issue of Dec. 4, has been attributed by the coronor's jury to the sudden opening of a main steam valve. The city boiler inspector stated at the inquiry that the investigation led him to conclude that this boiler was carrying 120 lbs. presure at the time, while the others were carrying only 90 lbs. He stated as follows: "From the investigation I made at the Swift plant, I came to the conclusion that there was more pressure being carried on the No. 8 boiler at the time of the explosion than there should have been. I found several of the safety valves after the accident and tested them. They appeared to be in good condition. It is my opinion that the steam pressure was allowed to rise higher on No. 8 boiler than on the rest of the boilers in the battery before connecting the same, and opening the main valve of No. 8 boiler, thus permitting the excessive pressure to escape suddenly. This, in my opinion, was the cause of the explosion. The main part of the jury's verdict was as follows:

From the evidence presented we believe that the explosion was caused by excessive pressure of steam escaping suddenly from boiler No. 8 in the ice plant, caused by some one in the boiler room opening the main valve of said boiler too suddenly. We find that Thomas J. Holmes, engineman, and James Owens, water tender, had complied with the city ordinances relative to being licensed engineers and water tenders. And we recommend shorter hours for a day's labor for men employed in such hazardous positions as engineers and firemen, where there is so much life and property at stake.

THE EXPLOSION OF THE OIL-BURNING STEAMER "Progreso" at a San Francisco dock on Dec. 3 caused not only the total wreck of the steamer, valued at $175,000, and the partial destruction of the wharf, but a loss of 12 lives. Besides 20 of the ship's crew, there were 40 mechanics at work on the vessel installing a petroleum-burning system, comprising 14 oil tanks, containing 400 bbls. of oil. There is little doubt now that the explosion was due to the use of an oil having a very low flashing point, and to the absence of vents in the oil tanks to permit the escape of gas accumulated above the oil. Actual test of the oil showed that it would flash at 85° F. The California Petroleum Miners' Association has petitioned the Board of Supervisors to require that all fuel oil shall stand a flash test of not less than 150° F., considering the present ordinance requirement of 110° F. as being too low.

THE PENNSYLVANIA R. R. TUNNEL FRANCHISE which has been before the Board of Aldermen of New York city for consideration for several months was granted on Dec. 16, by a vote of 41 to 36. The proposed work was described in Engineering News of Dec. 19, 1901. The first franchise asked by the railway company was thrown out on the grounds that the city was not properly protected or compensated by its provisions. Thirteen concessions were asked and of these the company consented to grant nine. They refused, however, to insert stipulations for an eight-hour day for employees, for the payment of the prevailing rate of wages, of the submission of disagreements with their employees to arbitration. The franchise was granted without these provisions. As the document stood when passed, it provided, among other things, that the city should have the right to readjust the rentals every 25 years; that the city might use the tunnel for fire and police telephone and telegraph wires; that the tunnel come under the police laws of the city; that the sanitary control be vested in the Department of Health and that the franchise should always be controlled by some company organized under the laws of the state of New York. The annual rental which the city will receive will be about $75,000 for the first 25 years, or until readjustment. Shortly after the favorable vote was announced, Vice-President Greene, of the Pennsylvania R.R., announced that construction would begin as soon as the engineers were ready with their plans.

THE BREAKING OF A MINE-CAR COUPLING caused the death of three miners in No. 3 slope of the Kingston (Pa.) Coal Co. The men were walking in the track behind the cars when a coupling broke and a string of cars dashed back down the slope at terrific speed. This is but one of hundreds of accidents where miners have not stayed in the manways, but have gone into the gangways where coal or ore is being handled.

HIGH PRESSURE PUMPING PLANT AND FORCE MAIN FOR THE WATER-WORKS OF PRESCOTT, ARIZ.

By W. W. Follett, M. Am. Soc. C. E.*

The city of Prescott, Ariz., having a population of about 4,000 people, is located on a spur of the Bradshaw Mts., near the center of the Territory, and at an elevation of from 5,400 to 5,550 ft. above sea level. Through the town runs a drainage line called Granite Creek, which is typical of arid region conditions. It is practically dry during 360 to 365 days in the year; the balance of the time it is a raging torrent.

Prior to the summer of 1900 the city obtained by pumping from a well sunk in the sandy bed of this creek a water supply generally sufficient for its needs. Early in that year, however, the supply ran lower than ever before, and was finally almost exhausted. In July a fire started when the reservoir was empty, and burned three-fourths of the business part of the town, and it became evident that the place must be abandoned or a new water supply must be obtained.

The nearest source which could be relied on to furnish the required 500,000 gallons per day was some springs at Del Rio, 20 miles north of Prescott, and at an elevation of 4,480 ft., or 1,135 ft. below the level of the city reservoir. These springs occur in the cropping of a cemented gravel stratum, in an open prairie, and furnish altogether some 4 cu. ft. per sec., or 2,600,000 gallons per day, of a constant and practically uniform flow. The water was appropriated years ago by the owners of four small ranches devoted to the raising of alfalfa. In order to obtain the right to take 500,000 gallons per day, the city had to buy two of these ranches, paying therefor some $15,000. One had some 30 acres in alfalfa and the other 50 or 60. This well illustrates the value of water rights in the arid region.

In August, 1900, Mr. Geo. W. Sturtevant, Jr., C. E., of Chicago, designed for the city council a pumping plant and pipe line to deliver in the city reservoir 500,000 gallons per day of this water, and afterwards took the contract under the name of the Phœnix Construction Co. to build the necessary works.

The writer was employed by the city to supervise the construction. Work began early in December, 1900. The pipe was laid by Mr. C. A. Weeks, Superintendent for Mr. Sturtevant, while the latter personally supervised the installation of the machinery. The plant was accepted by the city on Sept. 16, 1901, after a ten days' run of the machinery, during which time there was delivered in the city reservoir an average of 500,000 gallons each 24 hours.

*Consulting Engineer International (Water) Boundary Commission, United States and Mexico, El Paso, Tex.

THE PUMPING PLANT.

The pumping plant consists of the following parts:

One return flue tubular boiler 18 ft. long and 72 ins. in diameter, with 106 3-in. flues. One 165-HP. cross-compound condensing Corliss engine, with 12 and 22-in. cylinders, 36-in. stroke, and 14-ft. flywheel, with 25-in face. One triplex Deane power pump, with three double plungers 5½ ins. diameter and 18 ins. stroke, built to work against 725 lbs. pressure, and with 8-in. suction and 6-in. discharge. A Deane jet condenser; boiler feed pump; 150-HP. "even flow" heater for boiler water; and a reheater between the engine cylinders.

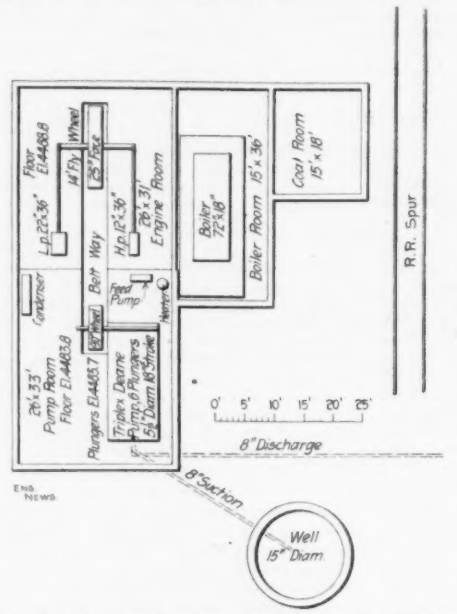


Fig. 1. Plan of Pumping Station for the Water-Works of Prescott, Ariz.

Fig. 1 is a sketch plan showing the arrangement of the machinery. The well was built in the largest spring, and three others were piped into it through a 6-in. drain pipe some 250 ft. long. It has in its side at water level a butterfly valve so arranged that when the pump is idle the water from the well flows freely into the stream. On starting the pump the water is drawn down about 4 ins. in the well, the valve closes, and spring water only is pumped. A continuous run of the pump for 96 hours, pumping about 515,000 gallons per 24 hours, failed to lower the water any more.

Fig. 2 is a photograph of the pump, with the driving pulley removed. It was set so the center of its horizontal plungers were 5.7 ft. above the water surface in the well when the pump was running full speed. It was built by the Deane Steam Pump Co., of Holyoke, Mass., and erected by the contractor. It made 32 revs. per min. day after day against 650 lbs. pressure per sq. in., with no heating and no hammer.

In the pump room are also the Deane jet condenser and the boiler-feed pump and heater.

The engine room floor is 5 ft. above that of the pump room, being level with those of the boiler and coal rooms. The engine, Fig. 3, was built by the Vilter Manufacturing Co., of Milwaukee, Wis., and was erected for the contractor by Mr. Chas. Borgnis, who came from the Vilter people. It is an excellent machine. The working of the dashpots and the forced feed oiler to the valves are especially commendable. It is belted to the pump by a 24-in. double-ply leather belt.

TEST OF THE ENGINE AND PUMP.

The coal used on the duty run of ten days was Gallup (N. M.) coal, and was a very light lignite. About 6 lbs. of water was evaporated per pound of coal burned, no allowance being made for ashes or clinkers. The average duty developed at the pump was 95,000,000 ft.-lbs. per 1,000 lbs. of water pumped into the boiler, no allowance being made for water caught at the throttle by the Austin separator or for steam used on vacuum and boiler feed pump. One 24-hour run on 32 strokes per min. of the pump developed 100,000,000 ft.-lbs. duty per 1,000 lbs. of water pumped into the boiler.

The pump showed no appreciable slip. The water pumped was measured over a weir at the Prescott pumping station and was practically the displacement of the plungers. The pump was run from 30 to 32 strokes per min. during the ten-day test. The weir showed that 32 strokes delivered at Prescott considerably over 500,000 gallons per 24 hours.

THE FORCE MAIN.

Fig. 4 is a condensed profile of the pipe line. The new pipe runs from Sta. 0 at the Del Rio pump to Sta. 1,017 + 40 at the old Prescott pumping station on Granite Creek. Here connection is made with an old 8-in. pipe line, which runs to the reservoir at Sta. 1,074. This profile shows all the details of the line, kind of pipe, location of all gate and check valves, air-chambers, valves

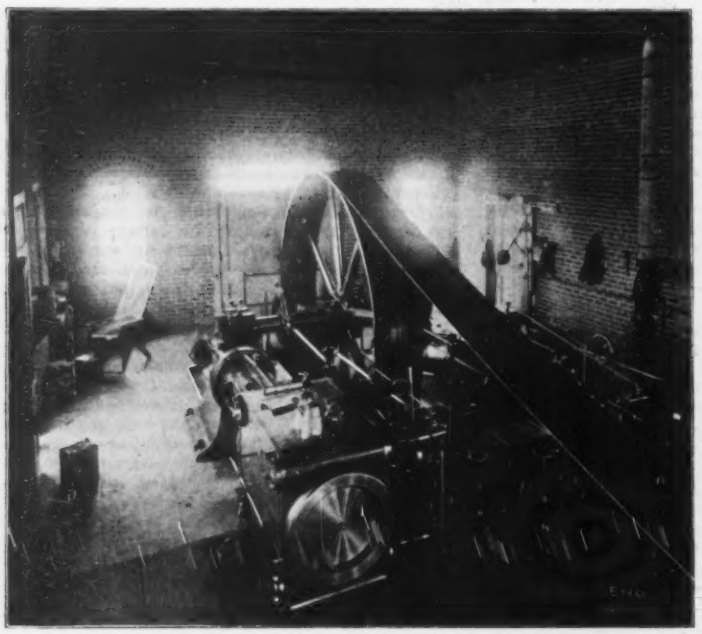


Fig. 2. 165-HP. Corliss Cross-Compound Condensing Engine.

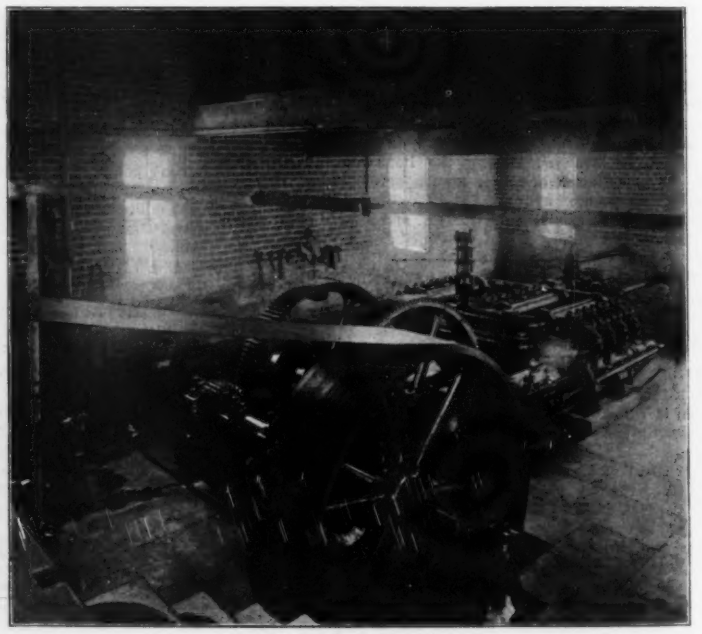


Fig. 3. 500,000-Gallon Deane Triplex Power Pump.

FIGS. 2 AND 3. VIEWS OF THE ENGINE AND PUMP BUILT TO WORK UNDER HEAD OF 725 LBS.

and cocks, and the lines of pressure when the pump is running 31½ strokes per min., or pumping 500,000 gallons in 24 hours. The pipe was laid with a minimum cover of 1½ ft., this being sufficient protection from frost in that latitude.

From Sta. 0 to Sta. 398 the pipe is 8-in. lap-welded asphalt-coated steel "line" pipe, 0.28-in. thick, tested to 1,000 lbs. per sq. in., and with taper screw joints, eight threads to the inch. The couplings are 8 ins. long and about ½-in. thick, with "blind" threads, i. e., the sleeve projects over the thread about 3-16-in. When laying this pipe the threads were painted with white lead and oil and screwed home as long as seven men on two chain tongs 8 ft. long could move the pipe by springing on the tongs. It was screwed into the sleeves from 10 to 14 threads. This pipe was quite flexible; it was laid around a 6° curve without any trouble and through a gulch at Sta. 25, where the vertical curve was nearly, if not quite, 6°. When pressure was put on the line there developed quite a number of small leaks in the first mile. These leaks were from defects in the threads caused by bruises received in transit, that portion of the pipe having been shipped with very light keepers. The rest had heavier keeps and no leaky joints were found. These leaks were stopped by calking into the threads a soft copper wire with litharge and glycerine and then upsetting the sleeve against it. Three lengths showed defective welds. One of these was clamped. The other two burst, presumably from water hammer, near the close of the ten-day pumping test. In each case the break was in a weld near the end of a length, and showed an imperfect weld. A short piece of pipe was cut out and a new piece screwed into the sleeve at one end and joined to the old pipe by a lead joint made as follows: A piece of extra heavy 9-in. steel pipe, 8 ins. long, was used as a sleeve. This was beveled on each end so it could be crimped down over the lead. It was centered over the joint and packed with yarn very tightly twisted and driven hard, leaving about 1½-in. lead space on each end. It was then poured with ordinary lead and two clamps ½ by 3 ins. put on the outside of the sleeve and drawn as taut as ⅝-in. bolts would draw without breaking. These were simply to reinforce the sleeve. The joint was then calked, rerun and calked, and the sleeve crimped down over the lead until the metal of the sleeve almost reached the pipe. A clamp of ½ × 3-in. iron was then put on the pipe, clamped home and driven close up against each end of the sleeve. One of these joints was only 700 ft. from the pump house, where it gets a pulsation from every stroke of the pump, and is under 645 lbs. pressure. It had stood the work up to the latter part of March without starting, and is still, I presume, in good condition. The joint was suggested by Mr. Sturtevant.

From Sta. 398 to Sta. 810 the line is 8 ins. outside diameter, lap-welded, asphalt-coated, steel "Converse joint" pipe, 0.14-in. thick and tested to 500 lbs. This is a well-known joint; it consists of a cast-iron sleeve with suitable lead space and sockets into which two projecting nipples on the end of the pipe engage and lock. One side of each joint is leaded at the shop and the other is made in the ditch.

Some 12 or 15 of the Converse joints showed leaks when the line was put under pressure. These were easily stopped by recalking and they stood nicely until within three or four days of the close of the ten days' duty test. Then three joints blew out, the lead being pushed out of the joint. I am told that a great deal of trouble was had with the lead starting in the joints for the first two months after the plant was turned over to the city, and that the joints on over half of this pipe had to be dug up and recalked. The writer is unable to account for this trouble. It was probably the result of a combination of adverse circumstances. The lead space is, in his opinion, too small for pressures over 300 lbs. (the pressure on the Converse joints ran up to 420 lbs.), and the pipe is so light that it will crimp under calking heavy enough for this high pressure unless it is very skilfully done. Water hammer, caused by pumping too rapidly when there was air in the line, may have started the lead, and it is quite likely that the lack of experience with such high pressures of all connected with the work caused poor workmanship. The line was finally gotten in satisfactory shape. Both the "line" and Converse joint pipe was made by the National Tube Works.

From Sta. 810 to Sta. 1,017 + 40 the line is an 8-in. longitudinally riveted steel pipe of No. 12 gage, heavily coated with a so-called enamel coating. The joints drive together, like stovepipe, and are reinforced by a band and lead joint. This was a reasonably good pipe for the pressure (from 140 to 210 lbs.), although some of the longitudinal laps leaked. The joint was too weak to stand the pressure. The wrought-iron bands were so light that they sprung under the blows of the calking hammer, and the pipe would crimp also, so that it was found almost impossible to drive the lead hard enough to make a tight joint. After going over all the joints from two to five times, the pipe was in fair condition when the writer left the work, in September, 1901. He is told that but little trouble has been found with this pipe since that date. It was made by D. J. Hooker & Co., of Los Angeles, Cal.

This plant is, so far as the writer knows, working under unique conditions for pumping water, raising it 1,135 ft., and transporting it nearly 20½ miles. Of course, there are comparable plants pumping oil. From his experience with it he would suggest that the Converse joint pipe was pushed a little beyond its capacity. The line pipe ought to have run to about Sta. 500. The Hooker pipe is not, in his opinion, suitable for this work, and ought to have been replaced by Converse joint. He thinks that the pumping plant cannot be improved upon. He believes that the belted pump is better than one direct-connected would be, because, in case of any sudden increase of pressure, the belt will slip and the pump stop. Both engine and pump are models for the work they have to do.

The total cost to the city, including supervision, but not including the water right, was $151,200; including water it was about $166,000. Probably $75,000 to $80,000 had been previously spent on pumping plants, wells, reservoirs, pipe system, etc. So that the present cost to the city of its water supply is about $240,000, or $60 per inhabitant. This is exceptionally high, but is a further illustration of the cost of water supply in the arid region.

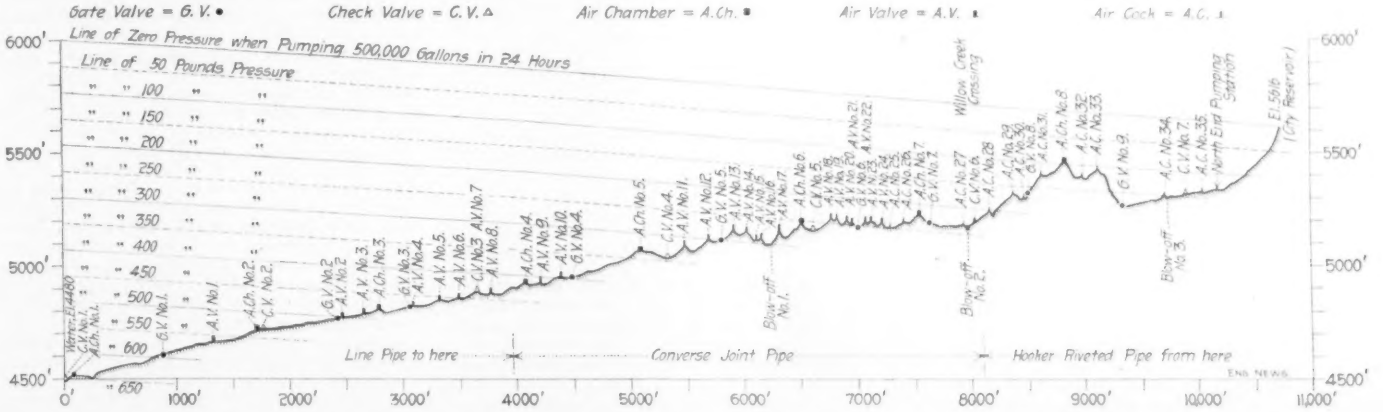


FIG. 4. PROFILE OF 8-IN. STEEL FORCE MAIN, 20.4 MILES LONG, WITH A RISE OF ABOUT 1,135 FT.

FLYWHEEL CAPACITY FOR ENGINE-DRIVEN ALTERNATORS.*

By Walter I. Slichter,† Jun. M. Am. Soc. M. E.

The following paper is written with the object of showing certain considerations which must be borne in mind when selecting a steam engine to drive an alternating-current generator which is to run in multiple with another generator or which is to generate power for a system in which synchronous apparatus, such as synchronous motors or rotary converters, are to operate.

A detailed analysis of the mechanical action in the engine which is the cause of the trouble is to be found in Mr. J. I. Astrom's paper, and the discussion thereon, read before this society last year at Milwaukee. I have omitted as much of the part that Mr. Astrom discussed as could be done and still give a clear idea of the effects in the electrical circuit.

An alternating-current generator, when direct-connected to a steam engine, is sensitive to certain irregularities in the speed of the engine which affect no other type of apparatus. This irregularity is in the instantaneous value of the speed, or the variation of the angular velocity during one revolution as distinguished from the changes in the average speed, due to a change of load or of steam pressure.

During one revolution the force applied to the crank-pin of a steam engine varies considerably, due to the following causes: (1) Transfer of reciprocating to rotating motion. (2) Variation in steam pressure on the piston, due to expansion. (3) Inertia of the reciprocating parts. (4) Weight of the reciprocating parts. (5) Throw of connecting rod. (6) Shortness of connecting rod.

Of these the first three are of the greatest magnitude. The first causes the torque to pass through zero twice in each revolution, the second causes the torque to be less in the second half of a stroke or impulse than in the first. The effect of the reciprocating parts is to diminish the torque in the first half of the stroke and increase it in the second half. Therefore, it is opposed to and counteracts the effect of expansion. The inertia effect is of considerable magnitude and frequently more than balances the effect of expansion. This is particularly the case in high-speed engines and in the low-pressure cylinder of a cross-compound engine, which is necessarily very large and bulky. The effect of the reciprocating parts is the most interesting, as it may be either harmful or beneficial—harmful in producing a peak at the end of the low-pressure stroke, where it overlaps the admission of the high-pressure stroke, thus merging the two impulses; beneficial in lowering the excess energy during admission of the high-pressure stroke.

In a single cylinder double-acting engine there are two impulses per revolution, and in a cross-compound engine there are four impulses. During the first part of the stroke the effort is less than the average, during the second part (equal to about one-half the period of the stroke) it is greater than the average. During the last part of the stroke the effort is less than the average again. This is shown diagrammatically in Fig. 1, Curve 1. Curve F is the varying crank effort or torque in foot-pounds at the center of the shaft. The straight line AG represents the average value or mean effort. The difference between these two at any time represents the excess or deficit torque, or the force acting on the flywheel or given by the flywheel.

*A paper presented at the annual meeting of the American Society of Mechanical Engineers, held at New York city, Dec. 2-5, 1902.

†Schenectady, N. Y.

This force F, acting on the mass M, of the flywheel, gives the wheel an acceleration $a = \frac{F}{M}$, or $a = \frac{F}{I}$, where I is the moment of the flywheel.

From a to b in the diagram the acceleration is negative and the speed drops (Curve 2), from b to d the acceleration is positive and the speed rises, the gain in speed from minimum to maximum (b to d), represented by S, being proportional to the area of the figure b c d, or it is equal to $\int a\,dt$. The acceleration is negative again from d to e, and the speed drops back to its original value at the end of the impulse to pass through a similar cycle in the next impulse.

While the speed is less than the average during the first

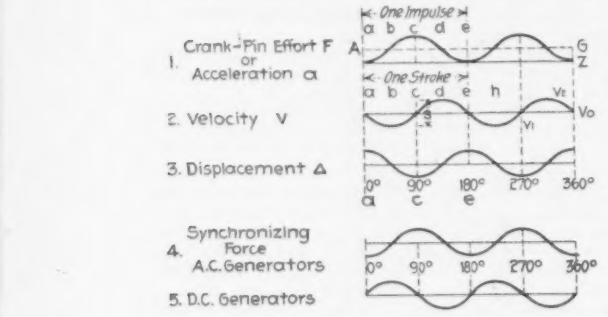


Fig. 1. Diagrams Showing Variation of Crank Effort, Speed, Displacement and Synchronizing Force, in Steam Engines.

half of the impulse (as from a to c, curve 2), any definite point of the revolving masses, as the crank-pin center, will fall behind the position it would maintain if the angular velocity were constant; and at c, where the speed becomes greater than the average again, it will have reached its greatest displacement and will commence to regain its correct position, which it reaches at d and passes to a displacement ahead of that of constant velocity.

The change of position from c to e, represented by $2\,\Delta$, is proportional to the area of Curve 2 between c and e, or is equal to $\int v\,dt$.

Thus we find that the displacement angle is proportional to the double integral of the curve of the unbalanced effort. This would be a long and tedious operation, but it is the only correct method of obtaining exact values. The method was given in the discussion on Mr. Astrom's paper. The work may be considerably shortened by the use of the integraph (of Coradi, Zurich), an instrument which will graphically integrate each curve in turn. By tracing the curve to be integrated with the pointer, a recording pointer will draw a curve, each ordinate of which is proportional to the area enclosed by the original curve up to that point. Its principal objection is that to get accuracy the original curve must be on a large scale, for the deduced curve is of such a scale that a 1-in. ordinate represents at least 4 sq. ins. of area in the original.

The displacement may be obtained approximately quite easily on the assumption that the curves are more or less regular and symmetrical, resembling sine curves. Let us represent the ratio of the area of the greatest peak of unbalanced energy to the rectangle representing the foot-pounds energy per revolution by k, so that we have

$$k \times P = P_1,$$

and

$$P = \frac{HP. \times 33{,}000}{(r.\,p.\,m.)},$$

where

k = unbalancing factor;
P_1 = unbalanced energy, in ft.-lbs.;
P = energy per revolution, ft.-lbs.;
HP. = output of engine;
r.p.m. = speed of engine.

Then we have:

$$P_1 = \frac{W}{2g}(V^2_2 - V^2_1) = \frac{W}{2g} V^2_0 \times 2s = k \times P,$$

where

W = effective weight of flywheel;
g = the constant of gravity;
V_0 = average velocity of W;
V_2 = maximum " " "
V_1 = minimum " " "

and

$$s = \frac{V_2 - V_1}{V_0}.$$

This s is the variation in speed shown in the diagram.

Having the value of s we must assume that the maximum variation from mean is $\frac{s}{2}$ and that the average value (from c to e) is $\frac{s}{2} \times \frac{2}{\pi} = \frac{s}{\pi}$. This average value of s lasts during one-half of an impulse, or, if n is the number of impulses per revolution, while the crank-pin is passing $\frac{360}{2n}$ degrees. Therefore the change in position during this time is $2\,\Delta = \frac{s}{\pi} \times \frac{360}{2n}$, and $\Delta = \frac{s \times 360}{4\pi n}$.

Combining these formulas so as to get Δ in terms of k, we get:

$$\Delta = \frac{k \times P \times g \times 360}{W\,V^2_0 \times 4\pi n}.$$

This is the displacement of the crank-pin from mean.

In a bipolar alternator the E.M.F. performs a complete cycle for every revolution; in a four-pole machine there are two cycles per revolution; that is, there is a cycle for every pair of poles per revolution, and if there are p pairs of poles on an alternator one cycle of the crank corresponds to $p \times 360°$ in the electrical circuit. Thus, if α is the displacement (from mean) in the electrical circuit, then $\alpha = p \times \Delta$, or many times the displacement usually calculated and discussed. The effect produced in the electrical circuit is due to this displacement rather than to the variation in speed.

Two sine waves of a given amplitude E, if they differ in phase by B degrees, have a maximum difference of $2E \sin \frac{B}{2}$. Thus, if two generators differ in phase B degrees, an E.M.F. of this maximum value is short-circuited through their joint impedance.

If we represent their full-load current by unity, the short-circuit current would be about 2.5, and the impedance $\frac{E}{2.5}$. Then the cross current due to this displacement would be:

$$i = \frac{e}{z} = \frac{2E \sin \frac{B}{2}}{2 \cdot \frac{E}{2.5}} = 2.5 \sin \frac{B}{2}.$$

Assuming a value for this cross current of 10% of full load current as a reasonable allowance, we have:

$$2.5 \sin \frac{B}{2} = .10,$$

whence

$$\frac{B}{2} = 2°\ 30'.$$

That is, a displacement of phase in the electrical circuit of 2.5° from mean will cause a cross current of about 10% of full load current to flow. Therefore we assume $\alpha = 2.5°$ as the limiting value of the displacement. This cross current heats the windings of the generators and may cause considerable loss of power in the resistances of the connecting cables.

The value $\alpha = 2.5°$ is one which builders of electrical apparatus have more or less generally agreed on as the limit, if satisfactory parallel running of apparatus is expected. If other conditions are favoroable, such as low resistance between generators, and few synchronous motors in circuit, the generators will work well in parallel with a considerably greater displacement, but when the conditions become exacting 2.5° is the limit.

A synchronous motor or rotary converter having a constant load tends to run at constant speed and has more or less flywheel effect in its rotating member. If now this is connected to an alternator driven by an engine which has an irregular angular velocity, giving a displacement from + 2.5° to — 2.5°, there will be a continual give and take of current between the two which may lead to the phenomenon known as hunting. That is, when the generator is ahead of the motor, the motor tries to catch up and takes power from the generator to do so; then, when the generator is behind in relative position, the motor tries to drag it along, and in so doing gives its power back again.

We have seen that the evil effect in the electrical circuit increases with p, the number of pairs of poles. Thus it is that high frequency generators give more trouble than low frequency generators. In most designs of engines the flywheel capacity necessary to carry the engine over a change in load while the governor is operating is sufficient to maintain the angular velocity within reasonable limits, but in cross-compound engines the inertia of the reciprocating parts of the low-pressure cylinder (the cylinder being so large) is usually so great that the crank-effort diagram is much distorted. Instead of getting four peaks per revolution, we get two or three, and each of these peaks lasts longer, the period of high speed lasts longer, and the displacement is greater.

There is also an aggravating action in the electrical generator itself, as pointed out by Mr. H. M. Longwell in a paper before the Engine Builders' Association last May. This is what may be called the synchronizing force, or torque, of the generator. As mentioned before, each generator, as well as each motor and rotary of the system, tends to keep in step with the rest of the system—that is, resists any displacement. If some external force causes a displacement, there occurs in the generator a torque proportional to the displacement, tending to bring the revolving part back to the mean position. If the displacement is backward, as at c of curve 3, Fig. 1, there will be a torque trying to pull the revolving part forward into step (as in curve 4, Fig. 1), which torque it will be noticed is greatest where the displacement is greatest, and where the engine effort is greatest; thus the synchronizing torque of the generator is in step with the unbalanced effort of the engine and additive thereto. Two generators connected in multiple will share the load between them at any instant in proportion to the angular displacement between them. If the displacement is not very great, the variation in load or, in other words, the synchronizing force in each is proportional to the sine of one-half the angle between them—that is, is proportional to the cross-current. Thus we find that at 2.5° displacement there is a torque equal to 10% of full-load torque tending to pull the alternator into step, and this torque occurs simultaneously with the excess effort of the engine and increases that excess and the unbalancing factor.

In the case of the 800-KW. set, the curves of which are given here as an example, we find a displacement of 3.4°, due to unbalanced engine effort alone, and this displacement causes a synchronizing torque in the alternator varying up to 15% of full-load torque as a maximum. This increases the unbalancing factor 30%, and would increase the displacement about the same amount. But this is an old plant and an unusually severe case (60 cycles). This shows that it does not necessarily follow that alternators of large synchronizing power will run in parallel better than those of small synchronizing power, but rather the reverse, though there are reasons why the other extreme is not desirable either.

It might be interesting here to note that in a continuous

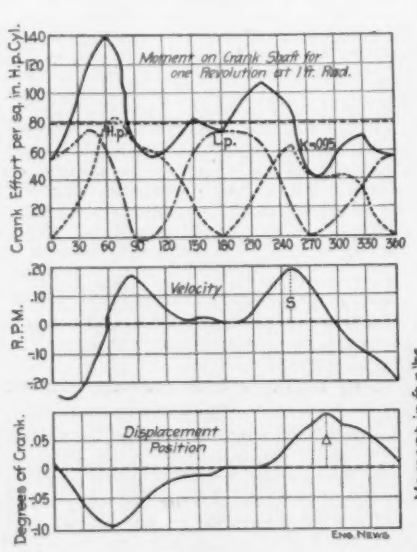


Fig. 2.

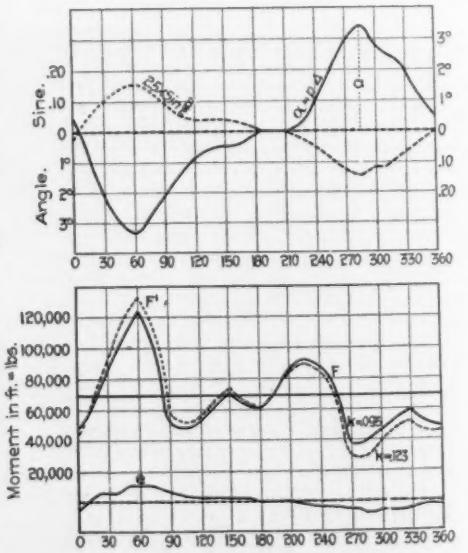


Fig. 3.

FIGS. 2 AND 3. VARIATION CURVES FOR HORIZONTAL CROSS-COMPOUND ENGINE DRIVING 800-KW. ALTERNATOR

current machine this torque is proportional to the speed instead of the displacement. When the speed is high the torque is negative, and when the speed is low it is positive, or additive to the engine effort. This is shown in curve 5 of Fig. 1. The effect of this torque is merely to distort the curve of engine effort, as it is displaced 90° therefrom. It is interesting to note that this torque is just opposite in effect to that of the reciprocating parts at any given time.

From a number of engines I have analyzed, and from data collected from some German and French technical publications and different American engine builders, it may be considered reasonable to expect an unbalancing factor of .15 to .30 in a single-crank double-acting engine, and .075 to .15 in a two-crank engine. But in the two-crank engine, as mentioned before, the distorted curve of effort usually gives only two displacements per revolution instead of the four we would expect; therefore, we may say that the "apparent" unbalancing factor is .15 to .30. A three-crank engine has about the same apparent unbalancing factor as a two-crank. A vertical engine gives a little more unbalancing than a horizontal, due to the dead weight of the moving parts, for which we should make some allowance.

To determine a weight of flywheel which would limit the displacement to a value approximately equal to 2.5°, I have derived a formula based on the above unbalancing factors with a reasonable increase to allow for overloads. While not always giving the most desirable flywheel capacity, since it would be impossible to take into account all the irregularities of some engines, yet it gives a value suited to the various conditions, such as frequency of alternator, style of engine, etc., such that if the engine is reasonably good we will get the results desired. If this weight of flywheel does not give satisfactory results it would be much better (for the electrical circuit) to make such changes in the engine itself as to give a better crank effort diagram than to increase the weight of flywheel, for a flywheel may easily give trouble by being too heavy.

As changes in the engine, I might suggest: (1) As best though most difficult, changing the angle between the two cranks; (2) changing the proportion of load taken by the different cylinders, and making the low-pressure take more load; (3) introduce compression at the end of the stroke to take up inertia, particularly in low-pressure cylinder.

The formula is:

$$W r^2 = \frac{KW. \times C \times 10^9}{S^4},$$

where

W = effective weight of wheel;
KW. = rating of generator in kilowatts;
S = speed of engine in revs. per min.;
r = radius of gyration;
C = a constant as follows:

	Horizontal single-crank.	Vertical cross-compound.	Horizontal cross-compound.
25 cycles	315	275	250
40 "	505	440	400
50 "	630	550	500
60 "	755	660	600
125 "	1,575	1,380	1,250

In some cases it is necessary to use a larger flywheel than this to carry the load during the short time it takes for the governor to operate. In railway power stations the load varies so greatly and so suddenly that an immense flywheel has to be adopted to meet these changes and the angular displacement has to be ignored. But so far as hunting and parallel operation are concerned, too great a weight of flywheel is almost as undesirable as too little, for a large inertia in the circuit means that much power must be expended in bringing any oscillating mass back into synchronism. Therefore, where a very heavy flywheel is not necessary for definite reasons, it is desirable to keep the weight down, and the weight necessary to limit the displacement to 2.5° will be found a reasonable medium value.

In many cases where hunting has occurred due to a pulsating prime mover or other cause, it may be held in check and practically suppressed by connecting a dashpot to the governor mechanism. This dashpot should have the characteristics that it is not sensitive to sudden changes in load or speed but that any prolonged change will cause it to move. This has been used successfully in practice to a considerable extent.

To determine by test the variation in speed of an engine is a very delicate and complicated experiment, and there have been many ways tried and suggested, but with very little success. At the meeting of the French Societe Internationale des Electriciens last winter this subject was discussed and many methods described. The most successful was that of E. W. Mix, in which a bevel-gear wheel is driven from the engine shaft by some very positive method—as gearing, or a bicycle wheel pressed against the engine flywheel. This gear-wheel drives in opposite directions two other bevel gears on concentric shafts at right angles to the shaft of the first gear. The outer hollow shaft of these two concentric shafts drives a light aluminum disk. The other gear-wheel is connected to a shaft consisting of a long elastic steel wire, and this drives a disk with a heavy flywheel rim. These two disks are placed side by side. One being light and connected by a rigid shaft, follows all the irregularities of the prime mover; the other, having considerable inertia and being driven by an elastic connection, revolves at practically constant angular velocity. There are slits in both disks, and by an arrangement of a light and mirror the relative displacement of the slits causes a beam of light to be deflected.

If an alternator becomes very much displaced in phase it may absorb power electrically and drag the engine along. If now the governor does not meet the condition properly, there may be no steam admitted to the cylinder; then at the end of the stroke the vacuum in the cylinder may be sufficient to draw water from the condenser, which may cause damage. Electrical damping devices are used in many cases to overcome these irregularities. They consist of short-circuited windings on the poles of the alternator. When the alternator oscillates ahead of or behind its correct speed, currents are generated in these devices which tend to oppose these oscillations. This is quite effective if the oscillations are rapid or of a short period, but, of course, it wastes power just in proportion as its effectiveness increases, being nothing more than a friction brake.

To give an idea of the flywheel capacity required to meet the requirements advocated and show that, contrary to the general opinion among mechanical engineers and engine builders, a very heavy wheel is not necessary, I append a table giving a comparison of the weights calculated by the above formula and those actually installed by the engine builders.

	Installed.	Calculated.
Altoona	13,000	11,000
Cleveland	41,000	75,000
Glasgow	148,000	164,000
Hanover	40,000	53,000
Baltimore	73,000	45,000
Metropolitan	240,000	193,000
Washington	15,100	17,500
Philadelphia	70,000	107,000
Omaha	24,000	18,000
Santa Catalina	34,000	21,000
Tornavento	72,000	44,000
Santiago	17,000	13,300
Milwaukee	50,000	40,000

EXPLANATION OF DIAGRAMS.

I give attached in Fig. 2, the curves of a horizontal cross-compound engine, cylinders 24 and 48 × 48-in. stroke, which is direct-connected to a 60-cycle alternator of 800-KW. at 100 revs per min. There were several of these in the station and there was considerable trouble from "hunting." It was finally necessary to put short-circuit windings on the poles and a dashpot governor on the engine, since which time the plant has run satisfactorily. The plant was laid out several years ago.

The irregular shape of the curve of combined high and low pressure crank efforts will be noticed. There are practically only two impulses per revolution. The maximum unbalancing factor is .005, is negative, occurs during the (high-pressure) return stroke, and lasts for 126°, or over a third of a revolution; this is the cause of the poor characteristics of the engine. If dead weight were added to the high-pressure piston the diagram would be improved, or if the angle between the cranks were less.

By integrating this curve of crank effort we get the velocity curve as shown, and by integrating this in turn we get the curve of displacement of the crank center, which shows very clearly the "two impulse" effect of the engine.

The maximum displacement is 0.095°. The generator has 72 poles; hence the displacement in the electrical circuit is $36 \times .095 = 3.4°$.

In Fig. 3, curve 1, is shown α, the displacement, and the broken line shows the variation in synchronizing force. In the lower part of the figure we have in full lines the crank effort diagram, and curve e is the synchronizing torque of the alternator in ft.-lbs. Adding these two together, we get the resultant unbalancing torque, which, as mentioned before, gives an unbalancing factor of .123, or 30% greater than that due to the engine alone. In these diagrams the high-pressure cylinder takes 47.5% of the load, and the low-pressure cylinder 52.5%.

NOTES ON WATER CONSUMPTION AND THE USE OF METERS.*

BOSTON AND VICINITY.—The daily consumption of water in Boston and the other cities and towns supplied wholly or in part by the Metropolitan Water-Works during the year 1901 averaged 101,492,000 gallons, or 120 gallons per capita. This was an increase of 7.1% over the previous year. The State Board of Health, in its special report of 1895, estimated that a consumption of 100 gallons per capita would be reached in 1920. The district included in the health board estimate appears to have been slightly different from that mentioned above, since elsewhere in the last report of the Metropolitan Water and Sewerage Board it is stated that the consumption in the district has increased from 92 gallons in 1895 to 117 (instead of 120) in 1901. Mr. F. P. Stearns, M. Am. Soc. C. E., is Chief Engineer of the Water and Sewerage Board.

*Abstracted from recent annual reports of water-works departments.

CAMBRIDGE, MASS.—The distribution of total water consumption among different classes of use is given by Edwin C. Brooks, Superintendent of Water-Works, in his report for 1901, as follows: Metered, 785,936,760 gallons; street sprinkling, 79,738,425; sewer flushing, 1,250,000; "cleaning sanitaries" (public water-closets), 7,500,000; drinking fountains, 35,000,000; testing meters, 113,595; domestic purposes, 1,835,617,660; total, 2,745,156,440 gallons. The domestic consumption appears to have been obtained by deducting all the other items from the total. The average daily consumption for 1901 was 7,520,976, or 54 gallons per capita. The per capita consumption in 1892 was 48 gallons. Meters are being installed, but thus far only a small percentage of the taps are metered.

FALL RIVER, MASS.—The distribution of water consumption is worked out in more detail at this place, and is given by quarters, as well as for the whole year 1901, as an appendix to the report of Mr. Patrick Kiernan, Superintendent of Water-Works:

Table Showing Distribution of Water Consumption in Gallons, at Fall River, Mass., for the Year 1901.

Domestic use; Manufacturing and trade purposes:	Total averages.
Metered	698,475,129
(a) Unmetered	68,750,000
5% loss of registration in meters	34,923,757
Public Uses—Buildings:	
(b) Schools	21,126,706
(b) Engine houses and police stations	17,778,127
(b) City hall—Building	801,535
(b) City hall—Elevator	3,212,968
(b) Almshouse	2,364,199
(b) City hospital	2,567,155
(b) City stable	434,048
Board of Health	.....
Miscellaneous:	
(c) Filling Pond South Park, Cemeteries, etc.	15,850,000
(f) Water troughs and urinals	100,650,000
(c) Wetting down at mills, July 4th	1,700,000
(g) Street watering carts	36,365,193
(c) Flushing sewers	27,275,000
(c) Puddling trenches—sewer and water	2,575,000
(d) Maintenance of water department:	
Filling tanks	2,750,000
(b) Testing meters, running lathe, etc.	1,735,401
(c) Flushing pipe & blowing off dead ends	26,175,000
(e) Fire, etc.	4,405,000
Total accounted for	1,069,914,216
Total pumped	1,320,839,810
Amount unaccounted for	250,925,594
Percentage pumped, unaccounted for	19.31
Total consumed by purchasers	802,148,886
Per cent. of above to total pumped	60.68
Of total pumped used for public purposes	20.01
Per cent. water unaccounted for, 1900	21.71
Same for 1901	19.32

(a) Figured on a basis of 3:1 of metered water. (b) Metered. (c) Estimated. (d) Capacity of tanks. (e) Estimated on time and size of streams in use. (f) Had meters set on several for a number of months. Estimated on basis of readings. (g) Number of loads and capacity of carts received from street department.

Of 7,075 services 6,755 are metered.

LOWELL, MASS.—Striking results from the use of 425 new meters are reported for the year 1901. The meters were set so as to begin the metered service on April 1. They showed 189 services using less water than they had been paying for at the flat schedule rate, and 236 using more than they had been paying for. At flat rates the total charges for these 425 services were at the rate of $18,132 per year, but the meter charges for the first quarter were at the rate of $18,132 per year; second quarter, $24,942; and third quarter, $15,589 per year. Mr. Robt. J. Thomas is Superintendent of the Lowell water-works.

LYNN, MASS.—This city accounts for all the water not metered by a series of estimates which include 5% for deficient registration of meters and 10% loss in distribution, the latter based on the total pumpage. The figures are as follows:

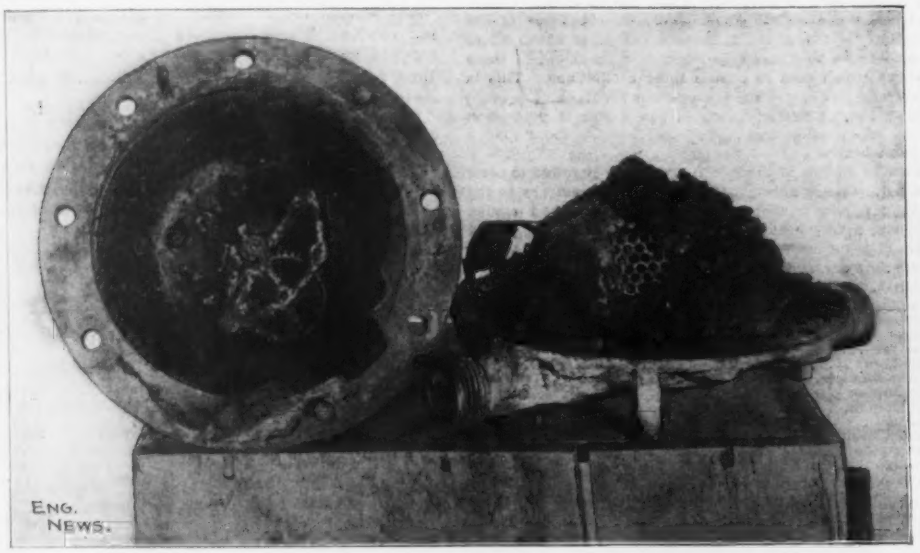
		Gallons.
Domestic, not metered		978,255,559
Manufacturing, metered		240,000,000
Domestic, metered		150,000,000
Loss in registration, 5%, estimated		1,950,000
Loss in distribution, 10%, estimated pumpage		164,467,284
City purposes: Street sprinkling	42,000,000	
Watering troughs	32,000,000	
Schools	13,000,000	
Fires	5,000,000	
Sewers	3,000,000	
Highway department	3,000,000	
Miscellaneous*	9,000,000	
		107,000,000
Total		1,641,672,843

*2,000,000 each for engine houses and fountains; 1,000,000 each for city hall, police station and health department; 500,000 each for cemeteries, public library, water department and all others.

The average daily water consumption for 1901 was 62 gallons per consumer, and slightly more

per inhabitant. Of the 12,722 services, 2,893 were metered.

MELROSE, MASS.—It is a rare thing, nowadays, to find anything unfavorable to water meters in the report of an officer responsible for the water supply of a city. Mr. W. Dabney Hunter, Engineer and Superintendent of the Public Works Department of Melrose, uses language in his last annual report that certainly indicates no great admiration for meters. He says persons with large water bills, on the schedule plan, believe



VIEW SHOWING METER AT MELROSE, MASS., NEARLY FILLED WITH RUST AND DEPOSIT.

that meters would reduce their water bills, and adds:

. . . If it did, it would also reduce the revenue, which is not desirable at present, as many of the old cement pipes have got to be taken out, the cost of which should be paid from the receipts.

This line of argument, we may interject, assumes that consumers under schedule rates are paying proportionately to the amount of water used. Mr. Hunter continues:

The adoption of meters would also increase the expense of maintenance, as a repair shop would have to be installed and a force of mechanics and inspectors kept continually at work. Meters are very apt to get out of order and unless frequently inspected and cleaned, do not register all the water passing through them. The accompanying cuts (see view reproduced from original of one kindly loaned us by Mr. Hunter.—Ed.) show the condition of two meters taken out the past season. They were entirely filled with rust and deposit and, although they still continued to register, did not register all the water passing through them.

The number of meters in use is given in the report as 82, and the number of water-takers as 3,707. We find no indication in the report of the water consumption of the city.

NEW BEDFORD, MASS.—The average daily consumption for the year 1901 was 5,891,000 gallons, a reduction of 430,000 gallons from the year 1900. This is attributed by Mr. R. C. P. Coggeshall, Superintendent, to: (1) a wet summer; (2) sealing private fire protection services "which have hitherto been used for other purposes;" and (3) the gradual introduction of meters. That there is room for a further extension of the meter system is shown by the fact that of 9,447 services only 1,566 are metered.

PHILADELPHIA, PA.—Although the pumpage of water was 7,212,000 gallons per day, or 10 gallons per capita, less in 1901 than in 1900, it was nevertheless 211.9 gallons per capita last year. This decrease, Mr. Frank L. Hand, Chief of the Bureau of Water, says in his report, "does not represent an actual decrease in the supply to consumers, but a greater efficiency of the pumps." In other words, as we understand the report, the pump slippage has been reduced. Further on, however, credit for reduced consumption is given to the introduction of self-closing hopper water-closets (in place of pan closets), and an unusually large number of repairs to leaky fixtures. Only 1,435 meters are in use.

A house-to-house inspection of 248,226 premises revealed the astonishing fact that 40,418 properties, or nearly one-sixth of the total, were paying no water rents. The rents chargeable against these premises amounted to $146,057 per year. The inspection cost $26,448, but the inspectors and extra clerks employed on the work were entered as laborers and paid laborers' wages. The total pumping capacity of the city water-works at the close of 1901 was 468,540,000 gallons. The works have been in operation for a hundred years.

CLEVELAND, O.—A study of the water bills of 73 consumers, taken at random, who had been under meter rates for from 15 years to only a few months, showed that only five

were paying more than they would have paid under the assessment system without a meter, and four of the five were cases where meters had been set but a short time, and where the waste of water is now being stopped, so that even these will soon show a reduction below the assessment rate.

On the other hand, readings of 36 newly-set meters, showed that for the first three months the consumers in question were using and wasting 203 gallons of water to every 100 paid for at the assessment rates,

and even without a minimum rate the meter [illegible] would have been 85% higher than the assessments. Twenty-six places, or 76% of all, revealed an increase, and only 8[illegible] showed a decrease, but as a result of the installation of meters in these places, the waste is being rapidly reduced, so that during the coming year the majority will find the meter a financial advantage.

Mr. E. W. Bemis is Superintendent of the Cleveland works.

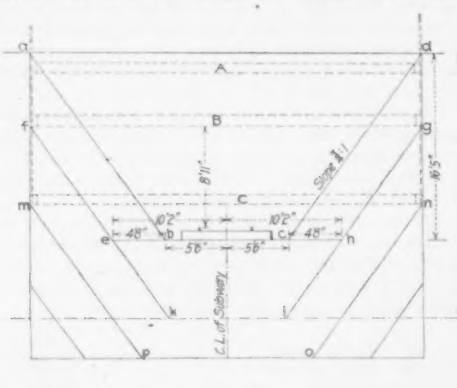


Fig. 3. Diagram Cross-Section, Showing Sequence of Excavation.

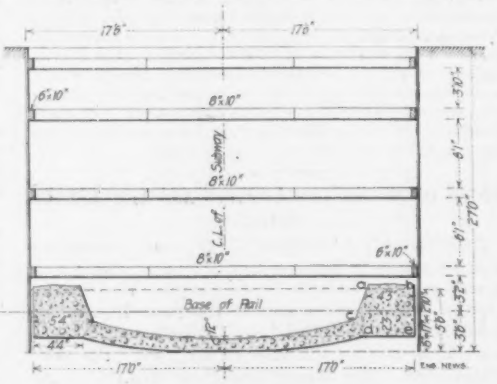


Fig. 5. Transverse Section of Subway Trench, Showing Timbering and Commencement of Concrete Work.

METHODS OF WORK ON THE ATLANTIC AVENUE IMPROVEMENT OF THE LONG ISLAND R. R.

The Atlantic Avenue improvement of the Long Island R. R. entrance to Brooklyn, N. Y., comprises, in general, the removal of the railway tracks from that thoroughfare to subway and viaduct structures, over or under which the traffic of the avenue and of the streets that cross it will pass. The general plan and purpose of the work, and the details of the structural subway, open cut and viaduct construction were quite fully described in Engineering News of May 22, 1902. To summarize briefly, however, the Long Island R. R. tracks now extend at grade along Atlantic Ave., and the work in progress is for the purpose of removing these tracks from the surface of that street. Beginning at the Flatbush Ave. station they will be transferred to subway for about 7,095 ft., then to viaduct for about 9,015 ft., then to subway again for 4,460 ft., and finally to viaduct for about 6,870 ft. The total length of viaduct and subway, with their open cut and embankment connections, is about 5¼ miles. Construction is now actively progressing on all of the subway and open cut work and on the foundations and electric wire conduits for the viaduct. The erection of the viaduct steelwork has not yet been commenced, although a large quantity of steel for Division No. 4 has been delivered for erection this year.

SUBWAY CONSTRUCTION.

The two sections of subway work are being done respectively by the Wilson & Baillie Mfg. Co., and John C. Sheehan & Co. The subway structure which these companies have to build is the standard construction described in our issue of May 22, with an outside width of 35 ft. and a height of about 20 ft. The width of excavation required was about 36 ft., and the depth varied with the relative subway track and street surface grades, but was, of course, always upward of 20 ft. The general method of work adopted by both contractors was to excavate a single wide trench, sheet and brace its sides and construct the concrete subway structure within it. In doing this work the plant and mode of procedure of the two contractors naturally varied in details. The work of each contractor will, therefore, be considered by itself.

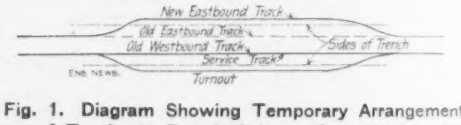


Fig. 1. Diagram Showing Temporary Arrangement of Tracks to Permit Subway Construction, Atlantic Ave. Improvement of Long Island R. R.

WILSON & BAILLIE MFG. CO.—The first stretch of subway work is being done by the Wilson & Baillie Mfg. Co., of which Mr. Gustave Kaufman, M. Am. Soc. C. E., is the engineer. The work may, for convenience of description, be divided into two parts, excavation and concrete work.

EXCAVATION.—The two tracks of the Long Island R. R. occupy the center of Atlantic avenue, with about the usual spacing of double tracks. The first operation prior to constructing a section of the subway was to rebuild one of the tracks by throwing it over toward the adjacent side of the avenue and to build a turnout of corresponding length outside of and parallel to the other track, which was itself left in place to be used as a service track. The old and new positions of the tracks, are described and indicated diagrammatically by Fig. 1 and also by the view Fig. 2. As will be seen from Fig. 2, the main tracks are thrown far enough apart to permit

the subway excavation to be carried down between them.

The method of sinking the excavation was to run trains of flat cars onto the service track and cast the earth directly onto them by shoveling from each side until a level about 3 ft. below the rails was reached. The service track was then shifted into one of the side cuts, and the center core and opposite side-cut were taken out by shovel to a depth of about 3 ft. below the new level of the rails. The tracks were then shifted

FIG. 4. VIEW OF BOTTOM OF TRENCH, SHOWING CARS AND CABLEWAY SKIPS USED IN MAKING FINAL CUTS.

to the opposite side of the excavation and third 3-ft. cut made. This alternate shifting of the tracks and cuts from one side of the excavation to the other side was continued until a trench 16½ ft. deep and 36 ft. top width, with side slopes of ¾ on 1, had been opened as indicated by the lines a b c d in Fig. 3.

The next operation was to drive 2-in. sheeting on each side of the trench to the depths f and g, as indicated by Fig. 3. The two upper cross-braces A and B were then set so as to leave about 9 ft. clearance between the lower cross-brace and the rails of the service track. This clearance was sufficient to allow loaded flat cars to pass under the lower brace, but was, of course, not sufficient to pass locomotives. When, therefore, the cars could not be reached by the locomotive a cable was used to haul them to a position ahead where a coupling could be made. As soon as the two braces were in place, the service tracks being at the center of the trench as indicated, the two side slope cuts a b e f and c d g h were taken out by casting the material directly onto the cars. When the side cuts were out the track was shifted first to one side of the trench then to the other side, until the section f k j h was excavated. The side sheeting was then driven down to the points m and n, and a third brace C was placed. This enabled the trench a m p o n d to be taken out. In a similar way the sheeting was driven to the points q and r and then to the points s and t, and the corresponding cuts were made which finally opened up the full section of the subway excavation.

Generally the final triangular cuts and a portion of the slope cuts preceding them were taken out by means of cableways. The cableway used for this purpose was installed when the work was first begun, and it was intended to use it for all of the excavation and not to use cars at all. After a little experience, however, it was concluded that under the conditions which prevailed the cableway was less economical and efficient than to shovel directly onto the cars. The use of the cableway was, therefore, relegated to the work of cleaning up the bottom cuts of the excavation and to such general work as it was able to do in handling material.

The cableway which was installed was a rather elaborate one. The towers consist each of two A-frames set parallel with and on opposite sides of the excavation. These A-frames are connected together across the trench by two pairs of trusses, one above the other, the trusses of each pair being on the same level and in the planes of the inclined legs, and also being thoroughly braced together. A transverse timber connecting the peaks of the A-frames carries the cables, which are three in number, with a span along the excavation of 720 ft. Fig. 4 shows the cableway skips on cars as they were handled at the bottom of the trench for cleaning out the final cuts. The cableway towers and cables are also shown in part by several of the other illustrations.

The completed bracing for the excavation is shown by Fig. 5, and also in part by Fig. 6. As indicated clearly by these illustrations, the 8 × 10-in. cross-braces span the trench, and abut against 6 × 10-in. waling timbers, which support the sheeting. They are spaced 15 ft. apart longitudinally of the trench, and to reduce the unbraced span of the waling between cross-braces a short diagonal brace is carried from each side of each end of every cross-brace to the center point of the waling timber between cross-braces. The arrangement of these diagonal braces is best indicated by Fig. 6. The other features of the trench bracing are clearly shown by Fig. 5.

The removal of the spoil after it was loaded onto the cars was done by the railway company. The company provided the empty cars and took away the loaded ones, furnishing motive power and train crew, the contractor saw to the maintenance of the service tracks and to the loading of the cars. The material penetrated was largely sand and gravel, containing loam and a considerable number of small boulders. It stood up well during excavation, and in addition the sand, with a little washing, proved suitable for concrete, and the boulders were likewise used for making broken stone. A glance at Fig. 2 shows the boulders sorted out and piled along the excavation ready to be collected and taken to the crusher.

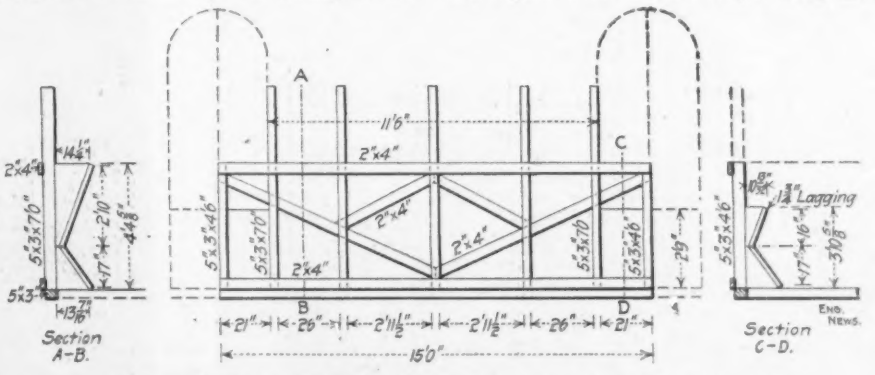


FIG. 7. DETAILS OF SKEWBACK FORM FOR CONCRETE SIDE WALLS.

CONCRETE WORK.—The construction of the concrete structure commences as soon as a reasonable length of trench has been opened. This structure consists of a concrete invert and concrete sidewalls, the roof being of I-beams resting on the sidewalls and having concrete arches between them. The first portion of the concrete structure to be built is the portion a b c d e, Fig. 5, of each sidewall. To construct this piece of wall use is made of the form shown by Fig. 7 to shape the face a c d. As will be seen from Fig. 7, there is a refuge niche in the sidewall every 15 ft., the floor of which comes below the point a, Fig. 5, and necessitates the special end construction of the form, which is shown by the section B B, Fig. 7. As soon as the base sections a b c d e of the sidewalls have been built the invert is constructed to template. The work is now ready for the completion of the sidewalls. These are plane surfaces, with an outward batter to the inside face of 3 ins. in 13½ ft. Forms consisting of lagging nailed to posts inclined to the proper batter and braced to the trench timbering, and by diagonal props to the center of the invert are used for the plain wall work. Where niches are to be built the special niche form, Fig. 8, is used. When the sidewalls are completed to the proper height the roof beams are placed and the arches between them constructed on suitable centers.

Fig. 6 is a view of the track system and plant for depositing the concrete. The stone crusher and concrete mixer are indicated in location by the smokestack shown in the lower right-hand corner of the view. This plant consists of a Blake crusher with suitable screens and crushed stone bins. From the bins the stone is taken by wheelbarrows to a bucket elevator which hoists it to a measuring box on an elevated platform. Other elevators take the sand and cement to the same level, whence they are discharged into a Smith concrete mixer. From the mixer the concrete is discharged into boxes on cars, and these cars are pushed along the tracks shown in Fig. 6, and discharged into chutes which lead to the work in progress. Here the concrete is tamped into place behind the forms.

Portland cement is used for all concrete work. The crushed stone is obtained, as already stated, by crushing the boulders taken from the excavation. The sand used is also taken from the excavation, but as it contains some loam in its natural state it has to be washed before being used. The washing is done by shoveling the sand into a box, into which a hose stream of water is fed and discharged through holes in one end and over the edges of the box. The current carries off the loam. The sand and stone as produced contain enough water to wet the cement and no additional water is used in the mixing of the concrete. Considerable difficulty has been met in obtaining a smooth surface to the concrete. The most successful plan so far has been to pull away the concrete from the face of the mold with forks so as to work the coarser stones back and then to give a thin grouting to the face.

JOHN C. SHEEHAN & CO.—The contractors for the second stretch of subway work are John C. Sheehan & Co. The method of excavation adopted by this company is practically the same as that described for the preceding work. The trench is opened to the full width and depth, and is braced before any of the concrete subway structure is

placed. Fig. 9 is a view of the first cut made before beginning the sheeting. In the distance is seen the first two cross-braces in place and the sheeting being driven behind them. The cross-bracing used is shown clearly by Fig. 10. In the distance is shown the two sheet-pile drivers used in driving the sheeting, and the three-leg derrick for handling and setting the cross-braces. No subway concrete work has yet been done on this contract, but a considerable amount of open-cut retaining wall has been built. The general plan adopted in doing this work has been to excavate two parallel trenches and construct the walls in suitable forms in them, leaving the center core of earth to be taken out afterward. The plant used by these contractors is somewhat more scattered than that previously described, but is if anything more extensive. It consists of a central crusher plant and of a number of concrete mixers scattered along the work, besides the pile drivers and derricks previously mentioned. The work is being handled systematically and rapidly.

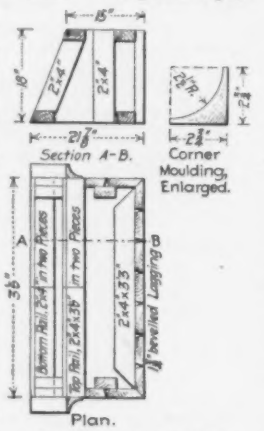


Fig. 8. Details of Form for Side-Wall Niches.

VIADUCT CONSTRUCTION.

So far the only work of viaduct construction has been the placing of the concrete column pedestals and the electric conduits. The column pedestal work is simple, consisting merely in excavating a pit, placing a form and filling it with concrete with the anchor bolts set in place by template. The conduit construction consists in excavating a trench and setting in it the vitrified tile conduits and placing manholes at suitable intervals, as called for by the plans.

THE RELATION OF THE ARCHITECT AND ENGINEER TO THE DESIGN AND ERECTION OF GOVERNMENT BUILDINGS.*

By John Stephen Sewell,† Capt., Corps of Engrs., U. S. A.

Inasmuch as both architects and engineers have much to do with the design and erection of modern buildings, and neither can do entirely without the other, it would seem to be a matter of prime importance that their relative positions be definitely settled in the beginning. This is a matter of more importance in government work than in private work, because of its greater extent under one ownership. The writer's plan, without elaboration of details, is simply this: The engineer should be a government official, with authority to disburse funds and make contracts; the architect should be in private practice. The architect, selected in some proper way, should, in general, be responsible for the design of the building, and the government, through its own engineers, should erect it.

If the government could develop a corps of salaried architects, with sufficient artistic ability, it would be manifest economy to do so; but the very nature of the case seems to make this impossible, and there is undoubtedly a very general sentiment that a "plan factory" is not conducive to the highest artistic excellence in building design. With this sentiment, the writer is in thorough accord so far as artistic features are concerned, although he believes that a well-conducted "plan factory" is an excellent thing when it comes to structural and other engineering work; so that he would always advocate the retention of a good architect in private practice, for the design of a government building. He would, for all important work, limit the selection to architects of well-proven ability; but on less important works, the competitions, or methods of selection, should be so devised as to give the younger men a chance to win if they can.

Coming now to engineers, there is no doubt that by a proper system of selection and tenure of office, the government could get an abundance of competent engineers at moderate salaries, to look after the execution of its building work. These men could easily be trained so as to do away entirely with the general contractor, and even with many of the sub-contractors, at a financial profit to the government and with considerable improvement in the standard of work. They would also be in a position to standardize many of the features of building design, which are now sadly in need of it. For instance, among the many so-called systems of fireproofing on the market, some leave little to be desired, some are very good, some fair, and many are wholly bad. A corps of building constructors employed by the government would be in a position to definitely settle which were wheat and which were chaff, and draw the line between them. Certain column sections are structurally good, others structurally bad; under present conditions, quite a percentage of the latter find their way into government buildings. The same is true of other details in all lines of building work, and this could be corrected by a construction corps such as that herein suggested. Above all, such searching inspection could be provided that the standard of workmanship would be materially raised. Contractors would be forced to learn that good work can be executed as cheaply as bad and it is not too much to claim that the general elevation of the standard on government buildings would exercise a similar and much-needed influence on private work.

A corps of building constructors, all well-trained and competent engineers, could, therefore, determine the best types for the various structural features of different classes of buildings; they could standardize specifications for both workmanship and materials; they could prepare the engineering plans themselves, if that proved advisable, or if not, they would at least, by the results of their investigations with the resources at their command, greatly simplify the architect's work on all but the purely artistic parts of the design. They would make all the contracts, control the various contractors, and be responsible that the approved design was properly and economically executed. But the architect's duties should so far overlap those of the constructing engineer that it should be his province to consult with the engineer on all points affecting the artistic value of the building, and on these points his authority should be superior to that of the engineer, except in those cases that occasionally occur where an effect is mistakenly sought at the expense of sound construction. In any event, the engineer, if he happens to take a narrow view of the artistic, should not be allowed to spoil the design any more than a general contractor in a like position.

So far the advantages of the proposed arrangement seem to be mainly on the side of the government. It may be claimed that a competent architect and an honest contractor could take a government building on the same terms as a private one and execute it with economy and a high standard of workmanship. This is perfectly pos-

*From a paper read at the annual convention of the American Institute of Architects at Washington, D. C.
†Engineer in Charge, New Building for Government Printing Office, Washington, D. C.

FIG. 2. VIEW OF ATLANTIC AVE., SHOWING EXCAVATION BETWEEN TRACKS.

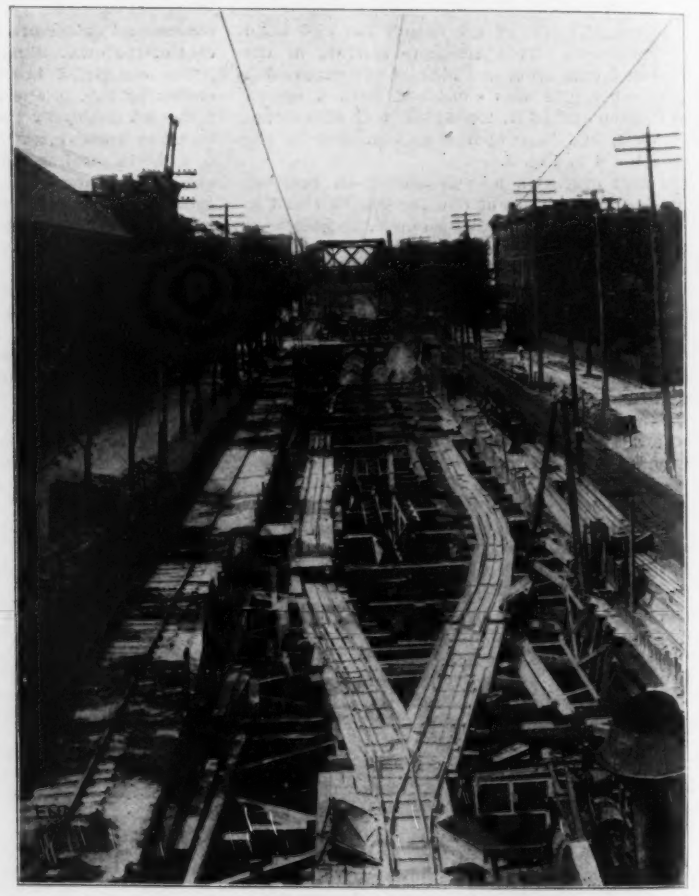


FIG. 6. VIEW OF TRACK SYSTEM FOR TAKING CONCRETE FROM MIXER TO WORK.

sible, but by no means certain, because the contractor is often a very uncertain quantity and must in any case have a profit, most of which could be saved by the method herein outlined.

It is almost certain that the average engineer, if left entirely to himself, in the design and execution of a building would produce at least a few architectural absurdities. Possibly, as an engineer, the writer may be so bold as to suggest that he has seen evidence that very good architects are sometimes a little weak on the purely engineering features of their work, as well as the relative economy of different details that are otherwise equivalent. He might possibly further sugest that here is where the engineer should come in; and if the architect has the benefit of the serious thought of many well-trained engineering minds instead of only one or two, the result is much more certain to be good. This is at least a fair argument for the architect and a regularly organized corps of constructing engineers, as against the architect and a clerk of the works of an engineer in private practice employed by the architect to supervise a particular building.

In any event, in government work, the money must be expended according to law and regulations, and every penny acounted for with a rigidity almost unknown in private work. Contracts must be made in accordance with a mass of statutes, rules and decisions that bewilder one not brought up among them. Any reasonable and necessary thing can be done, if one knows the established method of doing it, but, regardless of what the object may be, if the act is not in due form, payments will be stopped and contracts declared illegal by the accounting officers of the Treasury; contractors will not get their money, and the architect will probably feel that the tangle is utterly hopeless. The money must be disbursed by some government official. If the architect has the supervision of the work and certifies the payments due the contractor, the disbursing officer will probably be a man entirely without technical knowledge of building, and it may be quite possible for him and the architect to disagree as to whether a given payment is actually due under the contract. Unless the architect were bonded and held financially responsible for the payment, he could not compel the disbursing officer to make it in such a case, and it might result in tying up the work.

It may be asked if this building bureau personnel is made up entirely of engineers, who will decide between the various architects in a competition? Who will pass upon the artistic merits of the designs?

There should be a board of probably three eminent architects in private practice, retained to advise the constructing bureau in such matters, and their decision on artistic questions should be final. Of course, no one directly or indirectly interested in the competition should be eligible for membership on this board. The building once awarded to an architect, or firm of architects, they should be left entirely untrammeled in their work. The writer thinks this is more certain to follow if the constructing bureau is avowedly not composed of architectural experts. A little advice from the board of consulting architects should be a sufficient check on the design, if any is needed.

Inasmuch as architects, like the rest of mankind, are dependent for their existence upon a certain amount of the things that only money can buy, the question of compensation may also be raised. It is assumed that if the architect prepares all the plans and specifications, the usual percentage for such work would be a proper commission; it ought to be more liberal under the system herein outlined than any other, because so much of the engineering and structural design would be covered by the standard details and specifications of the constructing bureau. Fewer drawings would be required, and the specifications would demand not more than one-fourth of the usual amount of attention.

In case the constructing bureau did away entirely with general contractors, as the writer thinks it should, there would be a very decided economy in having the drawings for the steam, sanitary and electrical work, and also for foundations, structural features and fireproofing, made by its own draftsmen. In this case, the drawings could be made to serve at once as a basis for contracts for materials, as well as to interpret the design. The writer thinks this might be arranged with justice to all concerned, by having the architect supervise the preparation of these drawings, and paying him the full commission, less only the usual cost of such drawings to the architect himself. If this is not satisfactory, some arrangement could be devised whereby the government could secure this economy in the preparation of the drawings, and yet not be niggardly with the architect. Possibly, to make the nature of the proposed economy plain the writer should explain that his idea of the best way to let government contracts is to get unit prices on carefully classified and accurately scheduled bills of quantities. This puts the proposition before all bidders in the plainest and simplest form; encourages the lowest possible figures, and secures bids in many cases from responsible parties who have not the time to survey the drawings for themselves. It also provides automatically for extras, since they can always be paid for under the contract, within the limit of variations allowed in the quantities. It requires that the quantities shall be accurately figured from the drawings, and this can be done while they are in course of preparation, practically without extra cost, if the work is organized from the start with that end in view; whereas if done afterwards, it sometimes costs almost as much as the drawings themselves. In any event, if it were always accurately done by the government, it would not have to be done many times over by all the bidders; this would reduce the cost of bids as well as the percentage of contingencies on the contract itself, and if generally understood would reduce the cost of the work to the government.

Probably other minor questions of detail would be raised, and would have to be met; but the writer has no doubt whatever that if he has succeeded even partially in answering those suggested above, all the others could be disposed of without any trouble at all.

Finally, he would like to say that he has not, in intimating that improvement is possible in the existing order of things, meant to criticize any man, or any class of men, engaged upon government buildings; he believes that most of them are zealous and capable, which only confirms him in the belief that they could produce better results if organized under a better system.

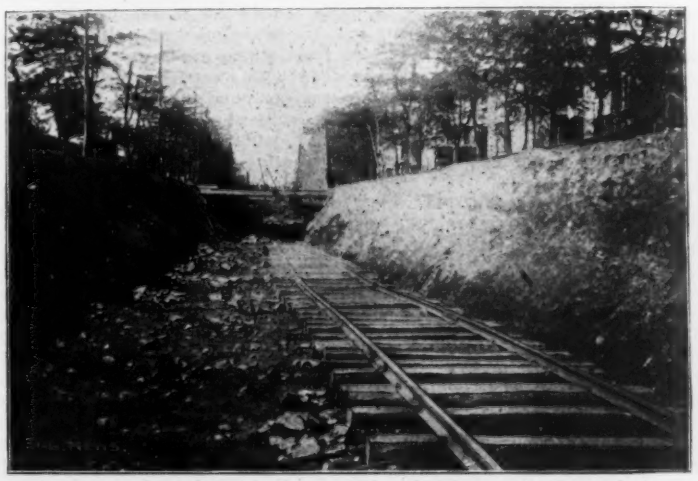


FIG. 9. VIEW SHOWING FIRST CUT OF TRENCH PREVIOUS TO SHEETING AND BRACING.

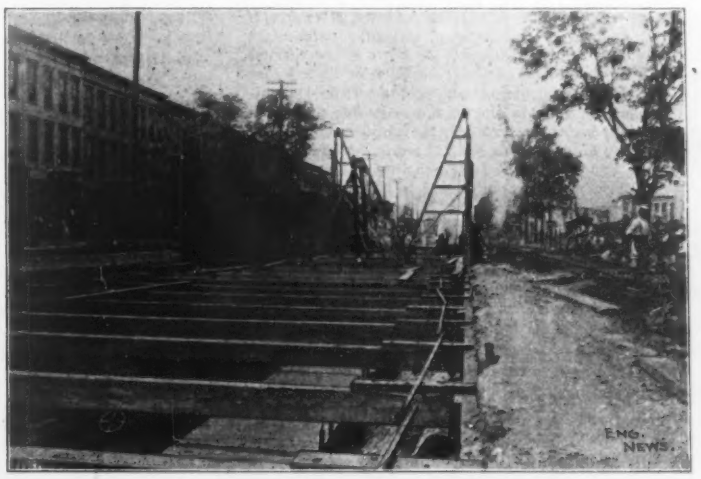


FIG. 10. VIEW OF TRENCH BRACING AND SHEET PILE DRIVERS.

SOME LOW FREIGHT RATES FOR WATER SHIPMENTS.

A Portland, Oregon, daily paper states that the first direct shipment of wheat from Portland to Sydney, Australia, is to be made soon. Two ships, the "Allerton" and the "Matterhorn," each carrying 100,000 bushels of wheat, have been chartered at 15 shillings ($3.65). In round numbers the distance is 7,000 miles, and if the rate given is per long ton, we see that the rate is a trifle more than 1-20 cent per ton mile. While such a rate is remarkably low when compared with freight rates by rail, it is nevertheless high compared with the lowest recorded rate from Portland to the United Kingdom.

Recently the ship "Christel" was chartered to carry grain for 17s. 6d. ($4.25), and as the distance is not less than 15,000 miles by way of the "Horn," in round numbers, the rate is about 1-35 cent per ton mile. But low as this rate is there are others still lower; for example, the French bark "Eugenie Fautril" was recently chartered at San Francisco to load for Europe, at 11s. 3d. ($2.73). Since the distance from San Francisco to the nearest European port, by way of the "Horn," is 13,000 miles* we have in this case a rate only a trifle more than 1-50 cent per ton mile.

It is obvious that rates to ports where a full return cargo can be got will ordinarily be less than to ports where no cargoes are to be had. Moreover the greater the distance, other things being equal, the lower the ton mile rate; for the time lost waiting for cargoes in ports forms a less per cent as the distance between ports increases.

As a standard of comparison we give certain rates per ton mile, found in the report of Gov. Roosevelt's Committee on the New York State Canals, as follows:

	Per ton mile.
Buffalo to New York by Erie Canal.....	1-5 ct.
Duluth to Buffalo, wheat, via Great Lakes....	1-15 "
Lake Superior to Ohio, iron ore " "	1-40 "
New York to France, wheat " "	1-12 "
San Francisco to Europe, wheat " "	1-33 "
Average by rail in U. S.....	½ "

A RELIEF MAP OF THE APPALACHIAN RANGE of mountains is being prepared by Mr. F. Cope Whitehouse for exhibition at the St. Louis World's Fair. This map is to include all the region which it is proposed to convert into a forest reserve, in North Carolina, Kentucky, Tennessee, Virginia and West Virginia, with a view of controlling or minimizing flood damage. The map is to be later presented to the West Virginia Historical Society.

CONCRETE BUILDING CONSTRUCTION in New York city is commented upon as follows by the New York "Record & Guide:"

The Manhattan Bureau of Buildings is not yet satisfied of the advisability of granting permission to several cement and reinforced concrete construction companies to introduce their systems here with the approbation of the municipal government. An exception has just been made in a case where a permit was granted for the construction of floors and partitions in a private residence, on the reinforced cement principle, where fireproofing was not required. The system to be used is the Hennebique. No fire test was made, and the Bureau states that the form of construction was passed because it promised something better than wood. The subject in general is still under consideration there. The Superintendent usually takes a conservative position in such matters. However, the cement men have gained something, which is at least an entering wedge.

The Bureau considers that in this form of construction much depends upon the workmanship, and that the greatest care must be given to the foundations and to the mixing of the cement. The Richmond Bureau of Buildings has apparently advanced farther than the Manhattan officials, inasmuch as an application by a construction company to erect a building entirely of reinforced concrete has been granted, following an examination supposedly thorough in its character.

Builders are generally agreed that cement will be the most popular building material of the future, but are not unanimous that any system of construction has yet been invented entirely equal to modern requirements. Great progress, however, has been made along this line, and it may be that only time and opportunity are needed to prove that the methods already available are entirely adequate.

*There is every reason to believe that the actual distance is nearer 15,000 miles.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, ... PRESIDENT.
D. McN. STAUFFER, ... VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, . . . TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, } ASSOCIATE EDITORS.

A. B. GILBERT, ... ASSISTANT MANAGER.

CHAS. W. REINHARDT, ... CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York, M. C. ROBBINS, Chicago, S. B. READ, Boston, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE. 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.00 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current Volume, 15 cents.

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 323 means that subscription is paid to the 32d week (that is the issue of Aug. 6) of the year 1903; the change of these figures is the only receipt, unless one is sent by special request.

ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

A new feature is presented to our readers in this issue, consisting of a special supplement devoted to engineering literature; and this is to be hereafter a regular department of Engineering News, appearing at monthly intervals.

We have for many years devoted much space to the publication of reviews of books and other engineering publications and have received many assurances that our readers have found these a valuable aid in the building up of their reference libraries. It has now been deemed best to bring this class of matter together in a monthly supplement instead of publishing part of it in the weekly Construction News supplement and another part at irregular intervals among our articles on technical subjects, as has been our custom heretofore.

A more detailed statement of the plan and aims of this new department is made in the supplement itself.

A fresh illustration of Coroner's Jury wisdom has been furnished at Chicago, where after dignified deliberation the jury which "sat" on the victims of the boiler explosion at the Swift Packing Company's plant returned the following verdict:

> We, the jury, believe that the said explosion was caused by excessive pressure of steam escaping suddenly from boiler No. 8 in said ice plant, caused by some one in said boiler room opening the main valve of said boiler too suddenly.

It must be admitted that the jury was in this case not so much to blame, since it was led to this verdict by the "expert" opinion of the city boiler inspector. He is quoted in the Chicago newspapers as saying that in his opinion the steam pressure was allowed to rise higher in this boiler than in the others of the battery, or to 120 lbs., where the others were carrying but 90 lbs., and that it was opening the main valve of this boiler, thus permitting the excessive pressure to escape suddenly, which was the cause of the explosion.

In the name of sound engineering and the public safety, we would register a protest against such a verdict. The idea that boiler explosions are due to the sudden opening of stop valves or safety valves rests on no sound foundation, and deserves to be condemned along with all the other crank ideas concerning boiler explosions. These false theories concerning boiler explosions mislead those responsible for the construction and care of boilers; and they come to overlook the fundamental fact that the primary cause of all boiler explosions is that somewhere the boiler was too weak to sustain the pressure. This weakness may be due to faulty design, to wasting of the metal by corrosion, or to its weakening by overheating; but it is weakness nevertheless,—strength insufficient for the load; and to fix attention on this and not on occult theories of boiler explosions is a necessity, if the casualties from boiler explosions are to be reduced.

Since the "sudden valve opening" theory is quite generally held, it may be worth while to explain just what it amounts to. So far as experimental evidence is concerned, it rests on the tests made by D. T. Lawson in 1882. These tests showed only that by suddenly opening *and then suddenly closing*, a boiler stop-valve it was possible to explode a boiler which was carrying a pressure much above its safe working pressure, although not higher than it had previously carried under static strain.

These tests, however, do not correspond to the working conditions of an actual boiler room, and while the tests have doubtless served to mislead many, the invention which they were made to exploit has never come into use. The fact is that with the ordinary screw stop-valve fitted to steam boilers, it is not possible to open or to close the valve quickly enough to cause any danger to the boiler, provided the boiler is otherwise strong and safe. Of course, if a boiler is on the point of letting go, any slight shock such as may accompany the opening of the stop-valve or the blowing of a safety valve, may be the last feather on its load. When such an explosion takes place, however, it is absurd to fix on the "sudden opening of a valve" as the cause of the disaster. The real cause is a boiler too weak for its load.

It is hardly necessary to say that this is not written to advocate the rapid opening of stop-valves. Careful opening is advisable to prevent priming of the boilers and consequent water in the steam pipe, and for other well-known reasons. The point we wish to emphasize is that this comparatively trivial matter should not be made to do duty as a scape-goat, so that the real causes of boiler explosions will be overlooked.

As to the immediate cause of the Swift boiler explosion, we cannot pretend, of course, to give an opinion. This much, however, can be said: That so long as the use of the ordinary externally-fired shell boiler continues, so long will there be occasional boiler explosions, the immediate cause of which will be difficult or impossible to determine. This type of boiler may be compared to a loaded girder or truss with its lower chord exposed to a fierce flame on one side and kept cool by a water bath on the other. Such a bridge is safe so long as the conditions are maintained; but if ever anything interferes and that lower chord is heated and weakened, the structure will fall. Among the many thousand such bridges in this country the wonder is that failures are not more frequent.

Our note last week, respecting the troubles of the Manhattan Elevated road in New York city with ice on the third rail, appeared at a particularly appropriate time, as on the day of publication of our last issue the traffic on the elevated lines was again completely demoralized, much more thoroughly even than on Dec. 5. The conditions were just those stated in our note last week. A rain began falling at a time when the temperature was below freezing, so that the rail became covered with a coating of ice. This occurred during the afternoon rush hour when trains were most frequent. It has been claimed, we believe, that if trains were kept running the contact rail would be cleared of ice as fast as it formed. The experience of Dec. 11 was an excellent test of this theory and proved it to be entirely groundless. If the contact shoes on Manhattan Elevated trains cannot keep the third rail clear in the rush hours, then it cannot be done anywhere. The rain began falling and freezing to the rail about 4 p. m. and in about a couple of hours the electric service was completely ruined. Such electric trains as continued to run were compelled to crawl at a slow pace and there was a constant succession of fireworks from the contact shoes and frequent burning out of fuses.

The only thing which saved the Manhattan system from a complete tie-up was the fact that a considerable number of locomotives are still in service. With these the road ran a partial train service during the night of Dec. 11, and the morning hours of Dec. 12. It was not till 24 hours after the storm that full electric train service was resumed.

We call attention to this matter not to question the wisdom of the change to electric traction on the Manhattan lines. That was a necessity for the benefit of the dwellers alongside its tracks, as well as those who ride upon its trains. The point which we would urge is that a remedy be speedily found and applied for this condition of affairs. Such storms as those of Dec. 5 and 11 are likely to occur half a dozen times every winter and neither the company nor the public which uses its lines can endure such interruption to its service.

As to the best device to remedy the difficulty, there is quite a field for mechanical ingenuity and the problem is complicated by the fact that the surface from which ice is to be removed is heavily charged with electricity and any device which is to operate upon it must be thoroughly insulated. We doubt whether any form of scrapers or brushes will prove effectual upon a smooth glassy coating of ice such as gave rise to the troubles on Dec. 11. The best chances of success would seem to be either an insulated wheel rolling on the contact rail and loaded heavily enough to crush the ice, or else an abrading or cutting wheel rotated at very high speed and kept in contact with the rail ahead of the collector shoe.

Of course, any such device involves more or less difficulties at frogs and switches; but these difficulties must be met if the third-rail system is to be made a success. We need hardly add that matters of this sort are of much practical interest to managers of steam railways in connection with the current discussion of the substitution of electricity for steam in suburban train service. It must be conceded that the steam locomotive trains are generally run with fewer interruptions due to weather conditions than has thus far been attained by either the trolley or the third-rail system of electric traction.

The numerous failures of wooden water tanks within the past few months must fill with apprehension all owners of such structures who are not in blissful ignorance of these accidents. Why should there be such failures? Our own conclusions are that a large percentage of wooden water tanks are built without the services of competent engineers, but can this be true of railway water tanks, in which class so many of the recent failures have been? Although no statistics are available it seems safe to say that 75 per cent. of the failures are attributed to bursting hoops. This is the portion of the tanks where the errors and false economies of rule-o'-thumb designers would be expected. Certainly there is need of reform in this class of construction.

A new system of block signaling for railway trains is described in an article on another page of this issue. Most readers of this article will be struck with the novelty of the method employed, and by the ingenuity of the means used to apply it in different cases. Devices which are fundamentally new in their nature are more rare than those which exhibit only a modification of arrangement. But they are also received with more caution than those of the other class; the mind

desires to examine and understand them not only in detail, but also as a whole, and in their relation to well-known things with which they are connected. Engineers interested in railway operation will no doubt wish to study the Miller signal system in this manner. We suggest here two thoughts as a starting point in this inquiry; we mention them not as the most important of the considerations which obtain, but as being rather broad and involved in the nature of the system.

The first of these is the almost complete elimination of fixed work, i. e., apparatus forming part of the permanent way. The elaborate and very expensive installation of signals and operating mechanism required in existing automatic or controlled-manual block signal systems has almost entirely disappeared in the Miller system; nothing is left but a compact relay instrument and a few cells of battery with short wire connections to the track, at the end of each block section, and a line wire connecting the different block points. In the case of the Chicago & Eastern Illinois installation even the line wire is absent, and the apparatus is now strikingly simple. The relay and the battery are easily arranged out of harm's way, yet so as to be readily inspected and cared for; the system then would seem to be proof against almost any interference, accidental or mischievous, and therefore to offer the maximum degree of reliability.

As an offset to this there is the equipment required for the locomotives. But this is small in amount for each engine, and quite simple, and there should be no extra trouble in maintaining it in efficient condition.

This is especially true since the arrangement used permits of the simplest sort of test of the engine equipment at any time: the engine-runner presses a button switch to open the circuit of the "clear" magnet, and his light must change to red at once, going back to white on passing the next block-point which has a "clear" indication.

On the whole, we find that by adopting the idea of engine-cab signaling, a remarkable simplification of the signaling equipment is realized. Corresponding, of course, a saving in first cost and maintenance of the signal equipment results. But entirely aside from this, the simplicity as such has a distinct value, even though this may be difficult to measure in dollars and cents; increased reliability, increased efficiency, and increased range of utilization, all of which usually come with simplicity, must surely represent an actual value, in railroad service as much as if not more than elsewhere.

The second thought we wish to suggest is one which will doubtless impress many signal engineers who study the system. As presented in our description, the Miller system employs but two signals, one expressing "clear," the other "danger." Since the latter signal is given one block in advance of the occupied block it must be analogous to the distant signal as ordinarily used; that is to say it indicates the position of the home signal one block ahead. Nevertheless it must be considered as indicating "danger" and not "caution," for the engineer cannot tell until he actually reaches the end of the block ahead whether he will find that block occupied or not.

Without presuming to make a definite statement, we venture the guess that the Miller system could, at the cost of a little added complication, be so worked out as to give three signals, i. e., "danger" or block ahead occupied, "clear" or two blocks ahead unoccupied, and "caution" or block ahead clear, but second block ahead occupied. However, the promoters of the system have elected to use only two indications, and the Miller system must therefore be judged on that basis.

Perhaps some railway officers may be inclined to look askance at the Miller system because the same indication is given for "second block ahead occupied" as for "block ahead occupied." Under proper rules, however, this should not lead to any danger. It must be remembered that in the Miller system as in the other automatic signal systems using fixed signals, the blocks are short. An engineer whose locomotive is equipped with the Miller system and who "gets the red lamp" at a block entrance, will at once get his train under control so as to pass into the next block at a speed of not more than say 5 to 8 miles per hour. If the red lamp still continues lighted he moves very slowly through this block, expecting to encounter an obstruction at any point, and he proceeds at this rate until he is stopped by a train or other obstruction ahead or until he gets a clear signal.

As seen by our descriptive article in this issue, the Miller signal is designed in conformity with the cardinal rule of safe signaling, that any possible defect in the apparatus must give the danger signal. It has the great advantage over fixed signals that in storms, fogs or bad weather the engineer has as clear a view of his signals as in good weather; and, further, that they are constantly before him. With fixed signals the warning is given as the train flashes past and an instant of dullness or absent mindedness on the part of the engineer leaves the warning unheeded. With the signal in the cab, the man who runs into danger has a red lamp shining in his eyes all the while and in plain sight also of his mate, the fireman.

The greatest gathering of engineers ever held in the United States was undoubtedly the Engineering Congress held in connection with the Chicago Exposition in 1893. In 1904 an opportunity will offer to repeat that gathering with the larger measure of success which the growth of engineering in eleven years should render possible. We know of no reason why all the national engineering societies in the country should not arrange to hold all their conventions at St. Louis in 1893 during the same week, as departments of the World's Congress for which arrangements are to be made.

SHOULD DYNAMITE BE USED IN CITIES?

In this issue will be found a set of rules that are hereafter to govern the use of explosives in New York city; and among those rules is one absolutely prohibiting the use of nitroglycerine. This naturally raises the question whether the use of dynamite should not also be prohibited; for dynamite is merely a "dope" in which nitroglycerine is absorbed.

The functions of this "dope" are: (1) To furnish a convenient medium for holding the nitroglycerine in horizontal or upwardly inclined holes; (2) to cushion the nitroglycerine so that shocks or jars will not explode it; (3) to add to the effectiveness of the nitroglycerine by introducing a cheap material in the form of the "dope" which itself explodes with the nitroglycerine; and (4) to retard the rapidity of explosion by introducing a more inert compound such as some "dopes" are.

To begin with, it is generally admitted that nitroglycerine undergoes decomposition when exposed to sunlight, or even in places where the temperature is 72° F. or more. At the temperature of boiling water it takes but a few hours to effect entire decomposition.

This decomposition in itself is not a source of danger, but during such decomposition the nitroglycerine is more easily exploded by shocks or by heat. A drop of pure nitroglycerine placed upon a hot iron or hot stove explodes with a report like a pistol shot. The sensitiveness of nitroglycerine to shock increases with the temperature. Eissler says that "at 350° F. the fall of a dime upon dynamite will explode it."

These are facts now so well known that there is no gainsaying them. It is beside the question to point to equally incontrovertible facts such as the dropping of a box of dynamite from a cliff 150 ft. high, or the firing of a bullet through a box of dynamite without exploding it. In such cases there is not the slightest doubt that the nitroglycerine in the dynamite was pure and at a comparatively low temperature, under which conditions it is admittedly safe.

The point is that nitroglycerine does explode uner certain other conditions which have occurred altogether too often in the past; and what is still more to the point is the fact that under certain conditions nitroglycerine will "leak" from the dynamite sticks.

Dynamite containing even ½% of moisture will "leak," the nitroglycerine oozing out between the folds of the paper cartridge; and exactly the same phenomenon occurs when the dynamite is heated to a point at which the nitroglycerine becomes very thin and fluid, as was stated by one of the witnesses before the Explosives Commission.

In fact the manufacturers are well aware of this "leaking," and pack sawdust between the sticks of dynamite, not more to cushion them than to catch and absorb any nitroglycerine that may leak out. The nitroglycerine in dynamite freezes at about 39° F., and after it is once frozen a temperature of about 46° F. is required to thaw it. Probably 99% of the accidental explosions of dynamite have occurred while thawing dynamite. Men ignorant of the "leaking" of sticks and the danger therefrom have placed the frozen sticks in hot water; upon removal from the water, the nitroglycerine has oozed out, and a drop then falling may readily explode. The same thing may happen by thawing over a hot stove, in an oven or over a steam pipe, where the temperature reaches a point at which this "leakage" occurs. We are not aware that any text-book writer on the subject has ever dwelt upon this one fact of "leakage" of nitroglycerine as the main cause of premature explosions; but it certainly merits most careful consideration.

Strangely enough pure nitroglycerine may be ignited with a match, yet it will burn without exploding. Indeed, sticks of dynamite have been used as candles. But all such experiments, while they tend to make the ignorant man more careless, should not for an instant make the careful man less careful.

Dynamite as we have seen can, and does leak under certain conditions; then liquid nitroglycerine is exposed to shocks and consequently to explosions. This being so, by the same process of reasoning which has led the Explosives Commission to exclude nitroglycerine from New York city, may it not be argued that dynamite should be excluded altogether?

The Commission refuses to test any of the safety explosives to determine their actual merits on the ground that it is not their province to indorse or condemn any particular explosive in the first place, and in the second place that the safety explosives being new can only be approved as substitutes for dynamite after years of use.

There is some weight in the last reason, but none at all in the first, for they have already condemned one explosive-liquid nitroglycerine.

As for their second reason, we believe that the Commission will agree with us that by far the greatest number of accidental explosions of dynamite have been due to poor methods of thawing.

Granting this, then it seems good logic to reason that a powder which requires no thawing (since it never freezes) is far safer than dynamite, other things being equal. The picrate powders are new in this country, but old abroad; they are not patented, and it is claimed that they are as effective as dynamite, and as cheap.

In view of these considerations we cannot help believing that it is within the province of the Commission to investigate the safety powders; and so far as the results of tests justify it, to give some decided advantage to the users of a safety powder.

It may be that since contractors using explosives must in future furnish heavy bonds, their bondsmen will insist upon the use of a safety powder. But where men have been accustomed for years to handling one kind of explosive it is exceedingly difficult to convince them that any other explosive is as good. Each foreman is apt to swear by his own kind of powder just as he swears by his own timepiece, even when its eccentric behavior is apparent to every one but himself.

We are not prepared to dogmatically assert that dynamite should be excluded from large cities, but since the Fire Department of New York has seen fit to exclude parlor matches we raise the question whether dynamite is not at least as dangerous to life, limb, and property.

THE 39TH ST. SEWER TUNNEL at Chicago was completed Dec. 11 as far as the excavation was concerned, the shields meeting with almost exact accuracy. The tunnel is 20 ft. diameter, and about 12,500 ft. long, from the lake to the river. The original contract was let to the Star Dredge & Construction Co., which failed, and the work has been completed by John Agnew & Co.

LETTERS TO THE EDITOR.

The Discussion of the Metric System Before the American Society of Mechanical Engineers.

Sir: As you may remember, almost the entire technical press reported certain resolutions passed by the members of the American Society of Mechanical Engineers at the Boston meeting of May 30, 1902, in an incorrect manner, and therefore you will no doubt be glad to make a correction in your report of the annual meeting just held.

On p. 509 you report that I "strongly urged the adoption of the metric system"; and also that "Mr. Henning moved that the report of the committee (the Metric Opposition Committee) be laid on the table."

If you will examine my written discussion, read at the meeting, you will see that I did not recommend the metric system by a single word or argument. I merely analyzed Mr. Halsey's argument without referring to the metric system in a manner which should lead my hearers to believe that I am a strong advocate of the system. I in fact stated that "its adoption made no difference to me." The records of the meeting will show you that I did not offer the resolution as stated by you. Yours truly,

Gus. C. Henning.

220 Broadway, New York, Dec. 13, 1902.

Introducing Metric Nomenclature.

Sir: In regard to renaming our present standards on the metric, it seems to have escaped the attention of the opponents of the international system of measurements that a very large number of our present standards are not an even number of divisions of any unit. For instance take your illustration on p. 501 of your recent issue. You say: "How then will you compel a plumber who wants a piece of 1¾-in. pipe to ask for a piece of 44.45 mm. pipe? The thing is simply impossible."

Now the 1¾-in. pipe is not standard, but the actual inside diameters of the ¼-in., ⅛-in. 1-in. and 2-in. standard sizes are in inches 0.364, 0.623, 1.048 and 2.067, and in millimeters: 9.25, 15.8, 26.6 and 52.5.

Supposing we should then call these sizes the 10 mm., 15 mm., 25 mm., and 50 mm. sizes respectively. We would still retain all the advantages of our present standardization, and the plumber would get far closer to the size of pipe he asks for than under our present lack of system.

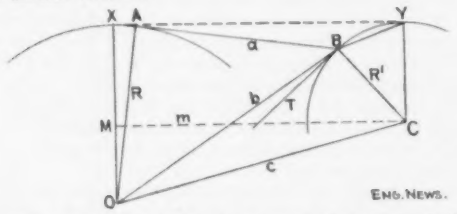
In fact, does not the state of measurements of standard pipes to-day prove absolutely that we can change to the metric system without giving up our present gages and standards?

Member of the American Society of Mechanical Engineers.

Boston, Dec. 12, 1902.

Another Method of Joining Two Curves with a Tangent.

Sir: The solution of the problem for finding a common tangent to two curves, given by Mr. C. W. Baldridge in Engineering News, Nov. 6, may sometimes be difficult to apply in practice, when the intersection point "I" is inaccessible, as with a line along a river bank. The trouble in making an intersection of tangents, if the angle is quite small, makes it desirable to have the intersection point some distance out from the proposed tangent line. Here is another solution:



From a convenient point, A, on curve whose center is O, produce and measure line A B (marked a) tangent to curve at A, until it intersects curve whose center is C.

At B measure angle A B T, and on diagram draw line O B, marked b,

$$\tan A O B = \frac{a}{R}, \qquad (1)$$

determines angle A O B.

$$b = \frac{a}{\sin A O B}. \qquad (2)$$

Draw line O C, marked c,

$$A B C = 90° + A B T \text{ (measured)}. \qquad (3)$$

$$A B O = 90° - A O B, \qquad (4)$$

and

$$O B C = A B C - A B O. \qquad (5)$$

$$O B C = A B T + A O B. \qquad (6)$$

In triangle O B C, having two sides and included angle known, solve for c and angle B O C.

Draw proposed tangent X Y, and the parallel through C to M (marked m),

$$O M = R - R^1; \qquad (7)$$

$$\sin M C O = \frac{O M}{c}; \qquad (8)$$

$$M O C = 90° - M C O \qquad (9)$$

and

$$X O A = M O C - A O B - B O C. \qquad (10)$$

With this angle X O A the distance from A to X can be easily found by the curve formula.

Tangent X Y may be produced from X, or the point Y may be determined thus:

$$O C B = 180° - O B C - C O B; \qquad (11)$$

$$O C Y = 90° + M C O; \qquad (12)$$

$$B C Y = O C Y - O C B, \qquad (13)$$

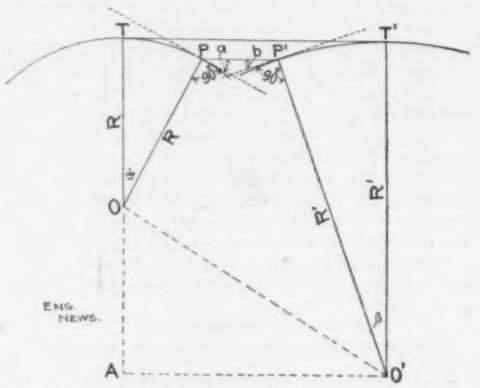
which is the angle sought, and the distance B Y can be found by usual curve formula.

E. H. Beckler, M.Am.Soc.C.E.

1838 Aldine Ave., Chicago, Ill., Nov. 12, 1902.

Sir: I submit herewith another solution of the problem of connecting two curves with a common tangent, thinking it may be of interest to some of your readers. I do not claim the credit for the original solution of the problem, as I learned the method from Mr. F. C. Tucker, who was formerly locating engineer for the Burlington & Missouri River Railroad.

Referring to the accompanying figure: In the field, assume P, any point on one curve, and P′, any point on the other curve.



With the transit measure the angles a and b that the tangents to the curves at the points P and P′ make with the line P P′. With the chain measure P P′.

Assume O as the starting point of a traverse and assume direction of O P (due north or south is preferable). Figure the traverse of the lines O P, P P′, P′ O′. From this traverse figure the closing course O O′, both for direction and distance. Having the courses of all the lines of the quadrilateral O P P′ O′ the angles are now known.

Produce T O to A until T A equals T′ O′, then O A equals R′ — R.

Now solve the triangle O O′ A from the known sides O′ O and O A.

Then

$$\alpha = 180° - (P O O' + O' O A)$$

and

$$\beta = 90° - (P' O' O + O O' A).$$

To further illustrate, we will solve an example:

Let

R = 573.7 = 10° curve;
R′ = 1,146.3 = 5° curve;
P P′ = 250.9 = measured distance;
a = 32° 10′ = one measured angle;
b = 17° 6′ = the other measured angle;
∴ P′ P O = 32° 10′ + 90° = 122° 10′;
∴ P P′ O′ = 17° 6′ + 90° = 107° 6′.

Assume the course of O P due north. Then we have the following traverse:

Course.	Distance.	N.	S.	E.	Total Lat.	Total Dep.
O P North.	573.7	573.7	....	0.0	N. 573.7	E. 0.0
P P′ N. 57° 50′ E.	250.9	133.6	....	212.4	N. 707.3	E. 212.4
P′ O′ S. 49° 16′ E.	1146.3	....	748.0	868.6	S. 40.7	E. 1081.0

log. cos 57° 50′ = 9.726225
log. 250.9 = 2.399501
2.125726 = N. 133.6

log. sin 57° 50′ = 9.927629
log. 250.9 = 2.399501
2.327130 = E. 212.4

log. cos 49° 16′ = 9.814607
log. 1,146.3 = 3.059185
113
2.873905 = S. 748.0

log. sin 49° 16′ = 9.879529
log. 1,146.3 = 3.059185
113
2.938827 = E 868.6

log. 1,081.0 = 3.033826
log. 40.7 = 1.609594
log. tang. 1.424232 = N. 87° 51′ W. = bearing of O′ O.

log. 1,081.0 = 3.033826
log. sin 87° 51′ = 9.999694
3.034132 . . . 1,081.7 = length of O′ O.

R′ — R = 1,146.3 — 573.7 = 572.6 = O′ A

log. O A = 2.757851
log. O′ O = 3.034132
log. sin A O′ O = 9.723719 = 31° 58′

90° — 31° 58′ = 58° 02′ = A O O′,

∴ 180° — (58° 02′ + 92° 09′ = 29° 49′ ∝ = amount to set back on first curve;

90° — (31° 58′ + 38° 35′) = 19° 27′ β = amount to set back on second curve.

log. cos 31° 58′ = 9.928578
log. 1,081.7 = 3.034132
2.962710 . . . 917.7 = length of required tang. = O′ A = T′ T.

It does not matter which side of the tangent point the points P and P′ are taken. It is only necessary to observe whether the angle read with the transit is read out or in from the tangent to the connecting line P P′.

It would seem that this method has one advantage over the method given by Mr. C. W. Baldridge, and that is, it is not necessary to run out an intersection which is quite difficult in rough timbered country.

The problem admits of a solution by the same method when the curves are reversed to each other. It is only necessary to observe carefully in which direction the angles are read so that the curve may be lengthened or shortened as the case may require.

Very truly,

B. C. Yates,
Asst. Engr. Homestake Mining Co.

Lead, S. Dak., Nov 13, 1902.

Notes and Queries.

We published a letter in our issue of Nov. 27, regarding the authorship of the treatise on Earth Roads, issued by Mr. A. J. Sager, of Climax, Mich. A correspondent familiar with the circumstances of the case assures us that the copying from Professor Baker's work without credit was done simply through ignorance of the customary practice in such matters, and not at all with any intention to claim credit for work done by others.

We have received an anonymous communication to which, since it raises an apparently fair question, we will give space, although it is against the rules of journalism. Referring to a note on "A Southern Water Power Development," on p. 389 of our issue of Nov. 13, the writer of the letter says:

You mention a total development of 14,000 HP., of which 6,000 is to be utilized at once. In looking over discharge data of the river prepared by the U. S. Department of the Interior, one finds a low-water discharge of some 700 ft. per sec. These observations were made by Mr. Max Hall, C. E., at Oakdale, some 20 miles below Atlanta; they cover many years and are no doubt very reliable. The question arises how is it possible with 700 ft. per sec., and a head of 50 ft., to get 14,000 HP., or even 6,000 HP.? Your reply may be the deficiency will be made up by storage. What a mighty large storage pond that will be! One hears of 20,000-HP. development on the Susquehanna River and the theoretical deductions arrived at in the same way! My idea in asking for this information is to ascertain how engineers arrive at the results.

The foregoing inquiries would be more effective if this critic had not himself gone to the other extreme by citing low-water discharge only. Without more data as to the variations in steam flow and their duration no one could be sure of his ground in discussing such questions.

MODERN CRANE PRACTICE IN A LOCOMOTIVE REPAIR SHOP.

The accompanying engraving is reproduced from a photograph taken in the new Collingwood shop of the Lake Shore & Michigan Southern Ry., and gives a good example of recent practice in the equipment of a railway repair shop with overhead cranes.

It is but a few years ago since the first overhead crane with capacity sufficient to handle a complete locomotive was installed at the Baldwin Locomotive Works; and in most railway repair shops the old transfer table system in connection with laborious hand work with block and tackle is still used to place locomotives upon the tracks in the repair shop or remove them therefrom. The advantages of the overhead crane system are so great, however, that it seems bound to come into increasing use. It does not take up a large area of valuable ground space like the transfer table system, nor does it require the roundhouse shop plan to be used as does the system where the tracks radiate from a turntable. The time and expense of hauling dead locomotives by hand power is also entirely obviated.

It is true that a considerable head room is required in the shop, and this makes the system difficult or impossible of application to shops already constructed. With the shop designed and built for the system, however, the high head room

makes the shop very light and greatly facilitate the progress of work. The contrast between such a shop as that illustrated and the old time locomotive repair shop, where most work in the pits required the aid of a torch is too great to call for further comment.

One objection often made to very heavy overhead bridge cranes is that they are ponderous tools to use for handling small parts. In the Collingwood shop this objection is met by providing

CRANE EQUIPMENT IN THE COLLINGWOOD LOCOMOTIVE REPAIR SHOP OF THE LAKE SHORE & MICHIGAN SOUTHERN R. R.

an auxiliary bridge crane service running on tracks far enough below the main crane track to clear the hooks of the latter. The column construction provided to carry the crane tracks and also the brick wall above the doorways will be of interest to many readers; as will also the bracing between the columns to stiffen them against side strains due to starting or stopping the large crane with its full load.

This large crane was built by the Niles-Bement-Pond Co., and is of 100 tons nominal capacity. It is shown in the photograph carrying an 80-ton consolidation locomotive. The crane is equipped with five motors. The two main hoisting motors are each of 45 HP. and can hoist the full load at 10 ft. per minute.

The bridge motors traverse the bridge up or down the shop, which is about 530 ft. long, at the rate of 150 ft. per minute with the full load, and 200 ft. per minute with light load. The bridge, which has a span of 65 ft. 6 ins. is of the Niles standard box girder construction, and is fitted with eight truck wheels running in heavy steel truck frames which are securely riveted to the box girders.

All gears on the crane are cut from the solid and run submerged in oil. Each trolley is equipped with the Niles automatic safety mechanical brake which controls the load at all times, and an electrical brake mounted on the armature shaft which is "on" when the current is thrown off. The motors are wound for 220 volts direct current, and each has its own reversible controller and rheostat.

HIGH-PRESSURE STEAM PIPING.*

By William Andrews.†

Twenty-one years ago, when Edison, at Menlo Park, brought out his electric lamp and called upon the engine builders, boiler makers and steam fitters to assist him with better apparatus, 80 steam-pressure lbs. per sq. in. was considered good practice. It is true that higher pressures had been used on steamboats and locomotives, but the majority of stationary engines used in factories and mills were slow-speed engines, piped with ordinary merchant pipe and screwed fittings, put up by any one who could use pipe tools.

About the year 1880 high-speed, compound, noncondensing engines were installed in the central station of the Edison Electrical Illuminating Co., of Brooklyn. This was the first prominent installation of engines of this type, and the specifications called for a steam pressure of 150 lbs. The pipe specification called for flanged fittings and full-weight special pipe, all to stand a working pressure of 150 lbs. There were no patterns for such fittings among the Eastern manufacturers, and, presumably, none among the Western foundries. At any rate the fittings were made to order from special patterns and they are carrying steam to-day at full pressure. In this station was introduced the "double system" of piping, which became a fad for a few years, but, like the American buffalo, has almost become extinct.

About this time copper pipe became popular for high-pressure work, probably on account of the ease with which it could be bent and formed into curves, which were just coming into fashion, but after a few years of use, having proved itself a very treacherous metal, it was discarded and now is very seldom used, except for expansion bends in exhaust pipes.

About 1892 wrought-steel piping made in the regular way became so reliable that it was used in making bends and steam mains, and at the present time it is so generally used that if an engineer wishes wrought-iron pipe, especially in the larger sizes, he has to call for it in his specifications and then wait for it to be made. Pipes, fittings, valves, pumps, engines and all material used in a modern first-class job are now required to stand a working pressure of 200 lbs. per sq. in.

Up to the year 1900 the almost universal design for a piping system for power plants was to carry a pipe for each boiler into a large steam header, whose cross section was equal to the sum of all the areas of the feeding pipes. If the designing engineer wanted to be very grand he made it larger without knowing just why. From this header, pipes were carried to the various engines, of sizes called for by the engine builder. It was quite common to place steam separators in each line leading to an engine, but fashions change in steam piping, as well as in clothes, and with the advent of high-pressure and superheated steam sizes of pipes have been very much reduced. In the four large power houses now built in New York city, with an ultimate capacity of from 60,000 to 100,000 HP. each, the largest steam mains are not over 20 ins. in diameter, and these are used more as equalizing pipes or storage reservoirs. Some of our best plants have pipes, which run from the header to the engine two sizes smaller than that called for by the engine builders. These pipes, before reaching the engine, are carried into a wrought-iron or steel receiver, which acts also as a separator. This receiver has a cubical capacity three times that of the high-pressure cylinder, and is placed as near as possible to the cylinder. The pipe from the receiver to the cylinder is of the full size called for by the engine builder. The object of this arrangement is, first, to have a full supply of steam close to the throttle; second, to provide a cushion near the engine on which the blow caused by the cut-off in the steam chest may be spent, thereby preventing vibrations from being transmitted through the piping system, and, third, to produce a steady and rapid flow of steam in one direction only, by having a small pipe leading into the receiver. This steam flows rapidly enough to make good the loss caused during the first quarter of the stroke. Plants fitted up in this way are successfully running where the drop in steam pressure is not greater than 4 lbs., although the engines are 500 ft. away from the boilers. This is probably the most radical departure in high-presure work up to the present time. Allowance for contraction and expansion is provided for by long bends, by using a double swing (like a gas bracket), on which the fittings turn on the threads of the nipple, and by producing what may be called initial tension. This can hardly be described in words, but is a rule of thumb method by which the skilled steam fitter puts a strain on the pipes when cold, so that when the pressure is put on the expansion removes this tension and there remains no strain on the pipe, other than that due to internal pressure.

Expansion joints of the old slip style, or those made of corrugated copper, have entirely disappeared from the modern first-class job.

As to quality of material, in the earlier days of electric light and railroad plants, owing to the difficulty of keeping the screwed joints tight, some engineers tried flanged cast-iron pipe for steam mains, but it was heavy and clumsy and sometimes cracked on account of the unequal expansion. Then came copper, and this pipe, even when reinforced with steel wire wound around it, was found to be a treacherous metal. Flanged cast-steel pipe was tried, but the difficulty of obtaining this free from blow-holes barred it out. At present the material used is either wrought-steel or wrought-iron pipe, on which the flanges are either riveted, screwed or welded. In England and on the Continent they weld a light flange to the end of the pipe and face it; it is pulled together when in use by a heavy steel or cast-iron flange, which had previously been slipped over the pipe, very much as copper joints are made in marine piping.

In 1880 the New York Steam Co. installed about six miles of steam mains under the streets of the city of New York for power and heating purposes. All the joints in this pipe above 8 ins. in diameter were made by expanding the pipe into recesses in the flanges, and then beading the ends of the pipe over the edges of the flanges. This was done by machinery, and was well done, and at the time was considered a great improvement over threading or riveting, but in five years every joint had to be taken out on account of leaks and threaded joints were substituted. These threaded joints lasted until 1895, when all the pipes were renewed with new mains having heavy wrought-steel flanges welded on the pipe. These welded flanges when turned true in the lathe make the most workmanlike and perfect steam joints in use at the present time, and their cost alone prevents their general use.

Gate valves are almost exclusively used in high-pressure work, as globe valves, especially in the larger sizes, would be very clumsy, and they would also make a pocket in the pipe. If gate valves are used often enough to keep them in good order they will remain tight many years.

Corrugated-copper gaskets placed inside the bolts and well pulled up will make a joint which will last as long as the fittings. The softer gaskets containing rubber, asbestos, or lead alloys need constant attention, and when superheat is used they are rapidly destroyed. When the owner's bank account is strong enough ground joints without any gaskets are used. This makes a first-class job, but the price is all but prohibitive.

One of the very necessary points of a first-class piping job, and one which is very often overlooked, is to have extra heavy fittings on the gage, lubricator and high-pressure drip connections. A break in one of these pipes, while it may not shut the station down, would cause great inconvenience and would be a nuisance until it was fixed.

The method of handling and disposing of the water of condensation has always been an open question. Some engineers think that the cheapest way is to draw it off through traps and discharge it into a hot well, and from there pump it to the boilers with other feed water. Others think that they can run the drips into the receiver of a pump and force it back while very hot—pump-makers favor this method. Gravity-return traps of the Albany, Pratt, Kelley and Bundy type have been used occasionally, and when well put up and taken care of they work well. The Holly gravity-return system is the latest, most scientific and best method of disposing of high-pressure drips. Its first cost sometimes deters an engineer from installing it, but when he finds that he can charge off the cost

*From a paper read at the annual meeting of the Engine Builders' Association of the United States.

†Mechanical Engineer, 26 Cortlandt St., New York city.

as an insurance policy on the life of the engine, on account of freedom from water in the cylinder, a beatific smile illumes his countenance and he orders it at once.

Vibrations which often accompany the installation of high-speed engines in our modern buildings are many times laid to the bad foundations or the unbalanced condition of the engine. In almost all cases it is not true; the vibrations come from the bad piping and can be, and in many cases have been, removed without touching the engine or foundations.

A WRECKED WOODEN WATER TANK AND A NEW STEEL STAND-PIPE AT MADISON, NEB.

By Arnold C. Koenig.* Assoc. M. Am. Soc. C. E.

The following account of the failure of an elevated water tank at Madison, Neb., and details of construction of a new stand-pipe, begun before the tank failed, may be of interest to the readers of Engineering News:

THE TANK FAILURE.

The tank in question was located on the side of a hill, at an elevation of approximately 100 ft.

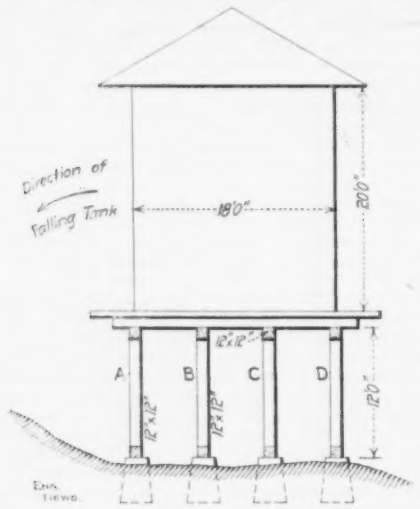


Fig. 1. Sketch Plan and Elevation of Elevated Water Tank that Failed at Madison, Neb.

above the business portion of the city. The top of the hill would have afforded an additional elevation of 25 or 30 ft., but is occupied by an old cemetery, which is the property of non-residents, and to avoid the delays incident to the complications in the title to the property, the new stand-pipe was located immediately south of the old tank, instead of at the top of the hill.

The tank was 18 × 20 ft., built of 3-in. cypress staves, steel hoops ⅛-in. thick, and varying in widths from 3 ins. at the top to 5½ ins. at the bottom of the tank, and tightened by means of bolts passing through cast-iron lugs, riveted to the ends of the hoops.

The tower consisted of four trestle bents, framed of 12 × 12-in. oak timbers, for sills, posts and caps, and joists or stringers of 3 × 14-in. white pine; total height about 12 ft.

The foundations consisted of stone laid in lime mortar, in the form of a wall under each sill, but the stone was of a very poor quality of rotten, stratified limestone, so brittle that while the construction of the concrete foundation for the new stand-pipe was in progress, the writer easily kicked out chunks as large as paving blocks, from apparently solid stones in the projecting portions of the foundations.

About six years ago, the condition of the tower was considered dangerous and bent "D" in the accompanying sketch (Fig. 1) was renewed.

On July 25, 1902, at about 10 a. m., the tank suddenly failed. It was nearly full of water at the time, and there was only a slight breeze stirring.

The description given by eye-witnesses is that their attention was attracted by the noise of breaking lumber, and as they looked up the tank appeared to sink, and then water gushed downward between bents "C" and "D." In summing up the various descriptions and examining the wreckage, it appears that, as the sills merely rested on a bed of mortar on the foundations, the rush of water pushed bent "D" outward so that it fell to the ground, the ends of the 3 × 14-in. joists projecting beyond bent "C" broke off, and then a reaction (which some one else may be able to explain) threw the tank over westward, as indicated by the arrow, leaving the 10-in. inlet pipe and bents "A," "B" and "C" apparently undisturbed. There was a joint in the inlet pipe about 5 ft. below the bottom of the tank, and the short piece of pipe extending from this into the tank leans slightly westward.

The crash of the fallen tank was distinctly heard all over the city, and every one seemed to know instantly what had happened, because the structure was long considered unsafe, and for several years has been leaning toward the east (down-hill) to such an extent that it was noticeable on the platform around the tank, even on the side-hill, where ordinarily a level platform would appear to incline in the opposite direction.

The peculiarity of the accident is that while the structure was known to lean eastward (toward the down-hill side) the east bent "D" of the supporting tower was the only portion of the tower that fell, and the tank itself was thrown westward (toward the up-hill side) entirely clear of the tower.

THE NEW STEEL STAND-PIPE.

The new steel stand-pipe, for which the writer was engineer, was designed last winter, and the contract was awarded to the American Bridge Co., under promise of completion by July 1, but owing to delayed mill deliveries, the shop-work was delayed and erection was not begun until Sept. 5. The structure was inspected and tested on Oct. 28. It is 20 ft. in diameter and 45 ft. high, with a conical steel roof and a Portland cement concrete foundation.

Figs. 2 and 3 show the details of the stand-pipe and its roof. The imported Portland cement concrete for the foundations (see cross-sections) consists of 1 part cement, 2½ parts screened sand, 2 parts gravel or stone screenings, and 4 parts substantial broken stone or granite, all by measure. For the domestic cement concrete the corresponding parts were 1:3:2:5 (broken stone).

The specifications for the steel work were practically the same as those given in Prof. Wm. D. Pence's "Stand-Pipe Accidents and Failures." The mill and shop inspection of the steel was made by the Osborn Engineering Co., of Cleveland, O.

Painting at the shop, as specified, called for "one coat of Sherwin-Williams carbon primer, or a similar paint of equal quality," applied with brushes or by dipping. The completed steel work was painted with dry red lead and raw linseed oil. To each gallon of oil there were added, for the first coat, 20 lbs. of lead and one pint of Japan, and for the second coat, 35 lbs. of lead and 2 lbs. or more of lamp-black, as required for the shade wished.

The contract price for the stand-pipe and foundations was $2,828. The concrete foundation work was sublet for $625 to Reimers & Fried, of Lincoln, Neb.

*New York Life Building, Omaha, Neb.

ANNUAL MEETING OF THE AMERICAN INSTITUTE OF ARCHITECTS.

The 36th annual convention of the American Institute of Architects was held at Washington, D. C., Dec. 11 to 13, 1902. The attendance was large, and embraced a large proportion of the leadng architects of the country in the section East of the Missouri river. The reports of the directors, secretary and treasurer, and of chapters of the Institute showed that it is in a flourishing condition.

It was announced at the meeting that the Institute had purchased the historic Octagon House, located in the city of Washington, as its headquarters, for the sum of $30,000. This building is one of the points of interest in the city, having been erected in the latter part of the eighteenth century. It is in an excellent condition of preservation, and has been fittted up in a manner which makes it an ideal headquarters for the Institute. $15,000 of the purchase money was subscribed by the members at the recent convention, of which $9,000 was actually paid. A special committee in charge of the raising of the entire amount is composed of Daniel H. Burnham, Chicago; George B. Post, New York; Charles F. McKim, New York; Frank Miles Day, Philadelphia and Cass Gilbert, New York. It was understood,

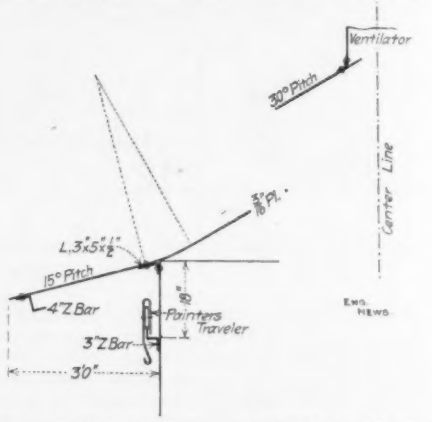


Fig. 3. Details of Roof of Stand-Pipe, Madison, Neb.

also, that an effort will be made to create a contingent fund of considerable proportions to be placed at the disposal of the Institute.

The following named gentlemen were elected to Fellowship in the Institute: William Rutherford Meade, New York; Ralph Adams Cram, Boston; George L. Heins, New York; John Lawrence Mauran, St. Louis; Elmer Grey, Milwaukee. Mr. Andrew Carnegie was elected an honorary member.

Mr. James K. Taylor, of Washington, Chairman of the Committee on the Metric System, reported that inasmuch as the question of the adoption of the metric system in this country was before Congress for consideration and action, the Committee had done nothing, except that it appeared before the Committee of Congress, and had concluded to await the action of Congress.

Mr. Frank Miles Day, of Philadelphia, Chairman of the Committee on Municipal Improvement, reported that the efforts of the Committee during the past year consisted in co-operation with the American Park and Out-Door Association, and that a paper on the relation of the American Institute of Architects to municipal affairs in general, drawing particular attention to the part that the Institute had played in the appointment of the Washington Improvement Committee, and the admirable work of that commission, had been read before that Association by Mr. Herbert Kelsey, on behalf of the Institute.

Mr. W. B. De las Casas, of Boston, read a paper on the Metropolitan Park System of Boston, in which he described the growth of this great park system, and gave especial prominence to the work

in connection with its development which was done by the late Charles Eliot, the landscape architect. It is a fact which seems hardly realizable at the present day that the park systems of American cities have nearly all been created since the Civil War. Prior to 1860, Fairmount Park in Philadelphia, Central Park in New York and Druid Hill Park in Baltimore were the only great public parks in the United States. Prior to 1870 Boston's parks consisted only of its ancient Common and the adjacent Public Garden of about 23 acres. At the present time the great series of parks and pleasure grounds serving Boston and 38 other municipalities adjacent to it, comprise nearly 10,000 acres, and have cost upwards of $25,000,000.

A paper of much interest to engineers was read by Capt. J. S. Sewell, Corps of Engineers, U. S. A., upon the relation of architects and engineers in the construction of Government Buildings. The paper is printed, nearly in full, elsewhere in this issue.

The following officers were elected for the ensuing year: President, Charles F. McKim, New York; First Vice-President, Frank Miles Day, Philadelphia; Second Vice-President, Alfred Stone, Providence; Secretary and Treasurer, Glenn Brown, Washington; Board of Directors (three-year term), Robert S. Peabody, Boston; William B. Mundie, Chicago; Isaac C. Ditmars, New York.

The annual meeting of 1903 will be held at Cleveland, O.

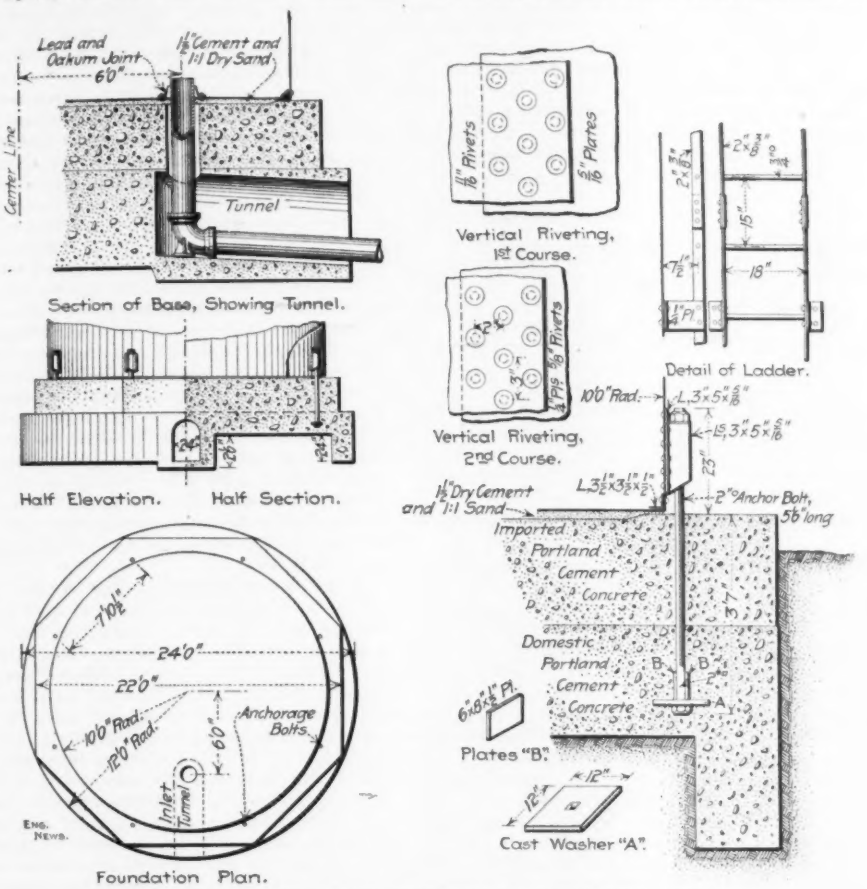


FIG. 2. DETAILS OF STAND-PIPE AT MADISON, NEB.

ADDRESS OF THE PRESIDENT OF THE INSTITUTION OF CIVIL ENGINEERS.

The recent Presidential address of Mr. John Clarke Hawkshaw, before the Institution of Civil Engineers, contains some interesting remarks upon the modern use and abuse of timber in temporary and permanent works of construction. He first objects to the term "old-world materials," as applied to wood and stone, in the Presidential address of Sir Frederick Bramwell, in 1884; and says that in that year timber might have been classed with equal truth as new-world material. In America particularly, at that date, timber was being used with a lavish hand in all sorts of engineering work; in wooden bridges and high trestles, in culverts, flumes, crib-piers and breakwaters, dry-docks, etc.; and it is still extensively employed everywhere where it can be secured. Mr. Hawkshaw, in dealing with Great Britain, in this connection says that for mining props alone, in 1901, 1,879,810 "loads" of timber were consumed; the railways of the United Kingdom contain about 90,000,000 ties, valued at about $90,000,000, and the annual renewals require 3,750,000. One of the large items of timber consumption, to which little attention is paid as a rule, is the use of wood in temporary work, as false works, supports, scaffolding, etc. The amount of this is rarely recorded; but in connection with the building of the Alexander Dock, at Hull, Mr. Hawkshaw found that while 482,000 cu. ft. of wood went into the permanent work, the temporary work consumed 1,500,000 cu. ft., or more than three times the amount.

The speaker said that while—for 30 years, the statement had been made that iron or steel ties were to replace those of wood, the use of the former was still very limited, even in countries like Germany and France that have to import the wood. The use of creosote prolongs the life of the wooden ties; and in England the average life of the wooden tie is about 24 years; or if applied to the mileage only, 22 years. The latter is very near the life usually credited to the steel rails. As an example of the value of preservatives reference was made to the use of beech ties in France. Untreated, these ties would only last from 2½ to 3 years, while when treated the life even exceeded that of oak ties. As to cost of maintenance, careful experiments made abroad show that this cost is less for metal than for wooden ties; but on the other hand wooden ties give a better and more elastic roadbed, with consequent increased comfort in travel and less destruction to rolling stock, and easier change and repairs at junctions and sidings.

Turning to the United States, Mr. Hawkshaw says that in our railways not less than 730,000,000 ties are laid, and the extensions and renewals in 1902 required about 110,000,000 ties. In addition to this consumption of wood, he estimates that from 80,000,000 to 90,000,000 cu. ft. of sawed timber are annually required for railway purposes in the United States. And to take the wooden ties now laid in the railways of the world, we reach a total of about 1,495,000,000, which Mr. Hawkshaw estimates as being worth $900,000,000.

As it is evident that much timber is still being consumed in the engineering work of the world, it is only prudent to enquire whether the future supply is likely to equal the demand upon it. Europe cannot supply its own demand, India requires its own Deodov forests and Siberia is as yet unworked and too far away; and Mr. Hawkshaw concludes that the only available source of timber supply for England is Canada. The vast tropical forests are of little if any help. The difficulties of transportation, the tangled undergrowth, the weight of the wood, and the scattered nature of the growth of really good trees make marketing commercially impossible. Canada is still credited with nearly 800,000,000 acres of forest; but all this is not timber-producing; and upon this the United States is making increased demands for wood-pulp, etc.; and with its enormous resources in water power, Canada will soon be a large consumer of its own timber products. The application of science to the growing of timber and to the care of forests may—and does arrest some of the present waste in growing timber, and the world at large is beginning to realize this fact. Mr. Hawkshaw thinks that it is time for Englishmen to realize what dear timber means, as directly and indirectly affecting engineering work; and his caution applies to other countries as well.

A NEW RAILWAY BLOCK SIGNAL SYSTEM.

The well-known Park Ave. tunnel, through which the New York Central & Hudson River R. R. enters the city of New York, has just been fitted with a new system of block signals, in addition to those under which it has been operated hitherto. The new signals, an application of what is known as the Miller system, differ radically from all other railroad signals. They are automatic, and depend upon an electric track-circuit, and to this extent they are similar to other automatic signals; the radical novelty of the Miller system lies in the fact that the signals are given directly in the engine cab. Two small electric lamps, one colored red, the other white, are mounted in the cab within easy view of the engineer; when the train enters a block, one of these two lamps lights up and remains so until the beginning of the next block is reached. If the track is clear for two blocks ahead, that is, if there is no train or part of a train in either of the two blocks ahead, then the white lamp lights up when the train reaches a block point; if either of the two blocks is occupied, the red lamp lights up. There are no fixed signals, such as semaphones, and the engine runner is guided entirely by the indications of the two little lamps in his cab.

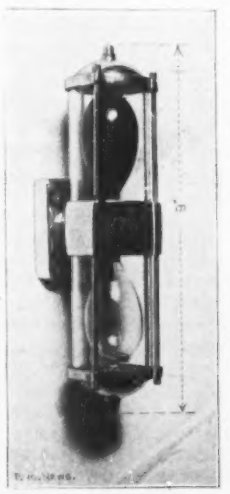


Fig. 4. Signal-Lamp Bracket for Mounting in Engine Cab, Miller Signal System.

The system possesses primarily the attractive quality of simplicity; it has also been found to be of great flexibility of adaptation. Previous to being installed in the Park Ave. tunnel, it was put in on the Chicago & Eastern Illinois R. R., on a stretch of about 3.5 miles, and it is there used as a complete and independent block system. The system as there applied is, however, of a special and more complicated form than the original type of the Miller signal system, due to certain particular requirements in the case. Again, the Park Ave. tunnel, where, as above mentioned, it has just been put in, was already fitted with the most complex system of signals known, an electrically

controlled manual system, and the new signals have been added to this installation without in any manner affecting its working.

The following description of the Miller block signals, as exemplified in several different applications, offers material for detail study of the system on the part of those interested in railway matters. It would seem worth such study if on no better grounds than the novelty of the idea and the ingenuity of the mechanism devised to carry it into practice. Our description is necessarily quite general, and only sufficient to indicate the working of the parts; the drawings presented are complete, however, and will enable the signaling mechanism to be followed out in detail. We illustrate and explain first the simplest form of the system, its original and type form, and then show the special modifications used on the Chicago & Eastern Illinois R. R., and in the Park Ave. tunnel, which were complicated by a number of conditions not provided for in the general form.

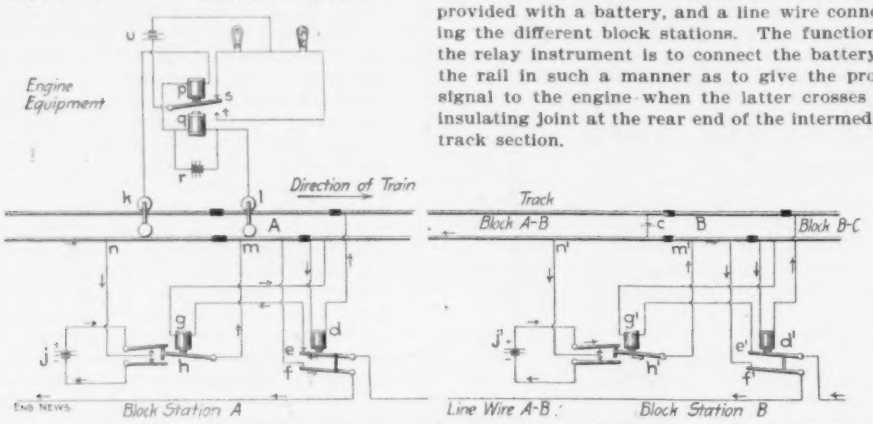


FIG. 1. GENERAL ARRANGEMENT OF INSTRUMENTS AND CIRCUITS FOR MILLER BLOCK-SIGNAL SYSTEM. Miller Signal Co., Chicago, Ill.

As already stated, the Miller signal system employs as indicators two lamps, one red, the other white, both being mounted in the cab of the engine. Fig. 4 is a view of a lamp-bracket as made for this purpose. The red and the white lamps are carried from a central base-piece, and are surrounded by protecting glass cylinders; spring supports are provided for the ends of the bulbs. Only one of these lamps can be lighted at any one time; the current for their operation is supplied by a battery, or other source of electricity, on the engine, and is switched on to one or the other lamp by an electromagnet reversing switch actuated from the track circuit. The lamps, battery and reversing switch constitute the entire train-carried portion of the signal equipment. The remainder of the apparatus is fixed, and may be called the track equipment. It is presupposed that the track is divided into blocks of convenient length (½ mile to 1 mile), and that at each block point a portion of the track a few rail lengths in extent is insulated from the rest of the track by insulating rail joints. The two rails in each block are utilized to form a track circuit for detecting the presence of a train in the block; a battery is placed across them, and when a train or car is in the block this battery is short-circuited through the wheels and axles.

The track equipment for the Miller signal comprises a relay instrument at each block station, provided with a battery, and a line wire connecting the different block stations. The function of the relay instrument is to connect the battery to the rail in such a manner as to give the proper signal to the engine when the latter crosses the insulating joint at the rear end of the intermediate track section.

GENERAL TYPE FORM OF MILLER SIGNAL SYSTEM.

The arrangement of the apparatus is shown in detail in Fig. 1, two consecutive block stations, A and B, being shown. The instruments at A and B are precisely similar. A magnet (d) has its coil connected across the rails at the rear end of the block, and when that block is clear the current from the track circuit energizes the magnet. The magnet has two armature contacts: one of these (f) communicates with the preceding block station through line wire and rail, by way of (m), (h) and (n); the other contact, (e), communicates with the succeeding block station, by way of line wire and rail, through the coils of a second magnet (g). This latter has an armature (h) which acts as a reversing switch for battery (j), and connects this battery with the points (n) and (m) of the rail, on opposite sides of an insulated joint. When armature (h) is attracted, as it is represented in Fig. 1, then the current from (j) tends to flow in the rail from point (m) to point (n); when (h) is dropped, the current tends to flow from point (n) to point (m).

The operation of the relay instrument and its electric circuits may now be readily followed out. When the track A-B is clear, then magnet (d) is energized by track battery (c) and attracts its armature. Similarly, when block B-C is clear, magnet (d′) at B attracts its armature. We have then an electric circuit as shown, from battery (j′) at B, through (h′) and wire (m′), through lever (f′) back to instrument A, energizing magnet (g), and back through rail A-B. Armature (h) is then attracted, and an electric pressure is set up from point (m) to point (n). When either A-B or B-C is occupied, then the circuit through the coils of (g) is broken, at (e) or at (f′), respectively, and armature (h) drops, so that battery (j) tends to send its current from (n) to (m) through the rail. This pressure between (n) and (m) is utilized by the locomotive equipment to give a signal in the engine cab when the engine crosses the joint between (n) and (m).

The engine equipment may have several different forms, one of which is shown above the track in Fig. 1. One axle each of engine and tender, (k) and (l), are insulated from each other, and are connected through the coils of two magnets, (p) and (q). The armature which plays between the poles of these magnets is adapted to make contact at (s) or at (t), completing the circuit of a battery (u) through the white lamp or the red lamp, respectively. When the engine crosses the insulating joint above referred to, the pressure between (n) and (m) causes a current to flow through the coils of magnets (p) and (q), and the direction of the current determines whether the armature is attracted up or down, to light the white or the red lamp. When the current flows from (k) to (l), then the armature is attracted downward, lighting the red lamp, and indicating that either block A-B or block B-C is occupied. When both blocks are clear the battery (j) sends current from (m) to (n) or by way of axle (l) to (k), so that the armature is attracted upward and the white lamp lights up.

It will be noticed that a small battery (r) is arranged on the engine for a local circuit through the coil of magnet (q), in such a way that no polarized armature is required, while at the same time the battery (r) acts to hold the armature in place, either up or down, while passing through the block. When an insulated joint is reached the circuit of (r) through magnet (p), by way of the rail back to (j), is broken, and magnet (q) being still energized, the armature drops and lights the red lamp. Thus the engine always gets a red signal the moment it passes an insulating joint, unless at the same moment the "Clear" impulse from the track relay operates to keep the white lamp alight. In order to avoid this action while crossing the insulating rail joint at the rear end of block A-B, this joint in the two rails is staggered longitudinally a distance of half a rail-length, or at least a distance greater than the interval between axles (k) and (l). [As shown in Fig. 1, the stagger is less than this, the engine equipment being shown to exaggerated scale, for the sake of clearness; properly, axles (k) and (l) should be shown a less distance apart than the stagger of the insulating rail joints.]

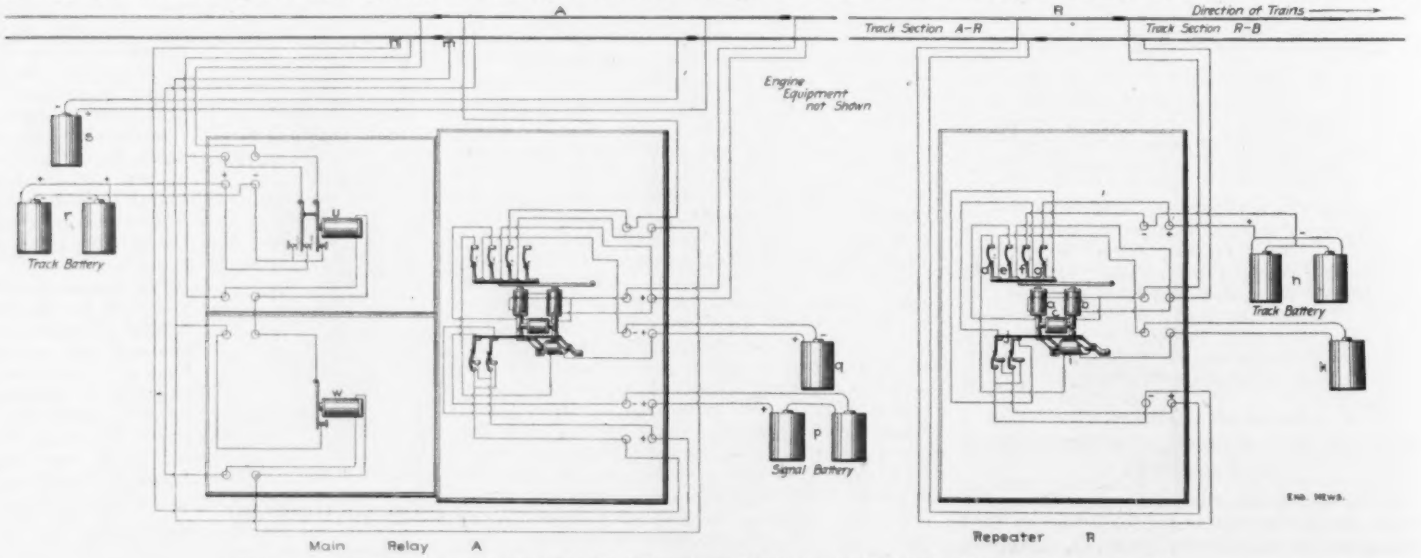


FIG. 2. "WIRELESS" TYPE OF MILLER SIGNAL SYSTEM AS INSTALLED ON THE C. & E. I. RY.

MILLER SIGNALS AS USED ON THE C. & E. I. RY.

For the Chicago & Eastern Illinois Ry. signal installation, a form of the Miller system was used which is characterized by the absence of any

wires connecting the different block points; that is, the entire signaling information, as to the condition of two blocks ahead, goes through the track circuit alone. What this means in still further simplifying the signal apparatus may be realized from the statement that the entire permanent or track-carried equipment now consists of a single relay instrument, with a battery of several cells, at each block station, connected to the track rails. It is clear that the track circuit now has three functions to perform: it must detect the presence of a train in the block, and it must report the following block either clear or occupied. It was therefore necessary to use a reversible track current, in connection with a "polarized" construction of relay instrument. An ingenious form of relay was devised for this purpose, which though utilizing the polarized armature principle avoids permanent magnets with their defects.

A condition often encountered in signal work is that the blocks, as laid out, are longer than is desirable for a single unreinforced track circuit. In such cases the block is cut in the middle by an insulating joint in each rail and a "repeater" is connected across, whose battery repeats in the second section the impulses arriving over the first. Where such repeaters had to be used on the present signal installation, the reversible character of the track circuit made it necessary to employ "polarized" repeaters, of a construction similar to the main relays. It may be mentioned that the section of line of the Chicago & Eastern Illinois Ry., on which the Miller signals were put in is not yet in regular traffic operation, so that although the signals are complete they have as yet not received the test of continuous operation under regular traffic conditions.

The system as installed is represented in diagram in Fig. 2, which shows one block station A and the repeater R intermediate between block points A and B. The engine-carried mechanism is not shown, being precisely similar to that in Fig. 1. The track arrangement of Fig. 2 is the same as Fig. 1, having a short piece of track at each block point separated by insulating rail joints from the track of the adjacent blocks themselves. An insulating joint is also placed in the middle of the length of each block, and the repeater R is connected across this joint. For a reason given previously, this joint is not opposite in the two rails of the track, but is staggered some distance, say half a rail-length.

Instead of explaining in detail the circuits and mechanism shown in Fig. 2, our description will confine itself to explaining the functions of the apparatus, leaving the reader to follow out the circuits. In order to make clear the "polarized" construction adopted in this case, the mechanism of the repeater will be described somewhat in detail.

It must be borne in mind that each block must carry a track current, in order to detect the presence of a train in that block. But this track current must also carry the information that the following block is either "Clear" or "Occupied." To do this, it is made reversible in direction; e. g., the track current in block A-B circulates, say, clockwise, when block B-C is clear, but anti-clockwise when B-C is occupied. The track current in A-B is supplied by a battery at B, and the relay instrument at B governs the connection of this battery to the rails of A-B; when B-C is clear, relay B connects the positive pole of the battery to the near rail and the negative pole to the far rail of block A-B, while when B-C is occupied it connects the positive pole to the far rail.

The functions of the repeater R must then be the following: when the current in track section R-B is clockwise, it must connect a repeater battery to section A-R, so that the latter track current circulates clockwise; similarly for anti-clockwise track current. When section R-B is occupied, so that its track current is short-circuited, then no current must be sent into A-R. How this is done may be seen by studying the construction of the repeater, as follows: Track current R-B is led through the coils (a) and (b) on the two legs of a horseshoe magnet; this magnet has an armature which closes four contacts when attracted. One of these contacts, (e), shunts a part of the track current through a third coil, (c), on the yoke of the same magnet. This coil is in opposition to coils (a) and (b), so that consequent poles are produced at the rear end of the horseshoe magnet, proper pole-pieces being provided. Opposite these poles is another horseshoe magnet, which is pivoted on a horizontal axis (this magnet is necessarily shown in perspective in our diagram). The coil (i) of this magnet receives current from battery (k) by way of contact (d) of the main armature. Now, as this connection is always made in the same direction, the poles of magnet (i) will always have the same sign; on the other hand, the consequent poles of magnet (a b c) may be of opposite sign depending upon the direction of the track current in R-B. Therefore, when this track current is in one direction, say, when the near rail is positive, then the two magnets have opposite polarites and magnet (i) is attracted. In this position it connects a track battery (h) to the rails of A-R, so that the positive pole of (h) is on the near rail of A-R. Contrarily, when the current in R-B is in the opposite direction, then magnet (i) is repelled, and by means of reversing contact points it then connects the positive pole of (h) to the far rail of A-R. Thus it will be seen that the repeater R always sends a current into rails A-R that has the same direction as the current arriving over R-B.

When track section R-B is occupied by a train, then no current from R-B reaches the repeater. The magnet (a b c) then does not attract its armature, and battery (h) is cut out of circuit, by contact points (f) and (g); no current is then sent into track section A-R.

The main relay instrument, as at A, is constructed on the same general lines as the repeater, and its operation may be indicated in a few words. The track current arriving over track section A-R energizes a horseshoe magnet with three windings, and a small local battery (q) energizes the pivoted electromagnet which forms a polarized armature. This latter carries reversing contact points which serve to connect the signal battery (p) to points (n) and (m) of the track rail. When the current arriving over A-R is in one direction, the polarized armature is attracted, and it connects the positive pole of battery (p) to point (m) of the track. In this condition, when the engine crosses the insulating joint between (n) and (m), it receives a "Clear" signal, i. e., its white lamp lights up. On the contrary, when the current from A-R is in the opposite direction, or when no current arrives over A-R, then the polarized armature is repelled or it drops, respectively, and the reversing contacts connect battery (p) to the track so as to give the red signal.

The instrument A must also supply track current to the preceding block, in the proper direction corresponding to the condition of block A-B. This is done by the reversing key (u), controlling the connections of battery (r). The current to energize magnet (u) is also supplied by battery (p) and the circuit passes through one of the four contacts of the armature of the main relay magnet, and also through a contact of key (w). The latter is a detector magnet for the short insulated track section; it is energized by a small battery (s). If the latter section is occupied by a single car or by a handcar, not projecting over upon the main block sections, then key (w) prevents a "Clear" signal being given at the preceding block station. This arrangement virtually adds the short track section at A to the main block A-B.

MILLER SIGNALS IN THE PARK AVE. TUNNEL OF THE N. Y. C. & H. R. R. R.

The complicating conditions met in installing the Miller signals in the Park Ave. tunnel have already been referred to. Fig. 3 shows a diagram of the completed signal work; the mechanism and circuits shown below the line of the track represent the "existing" work, the new work being shown above the track. The engine equipment is again omitted, being identical with that shown in Fig. 1. The great complication of the combined set of signal circuits and relays is readily inferred from Fig. 3. However, the new portion is not as complicated as may at first be thought, since it consists of one relay instrument, containing two electromagnets, at the home signal station, and one relay, of three magnets, at the distant signal; the different stations are connected by line wires.

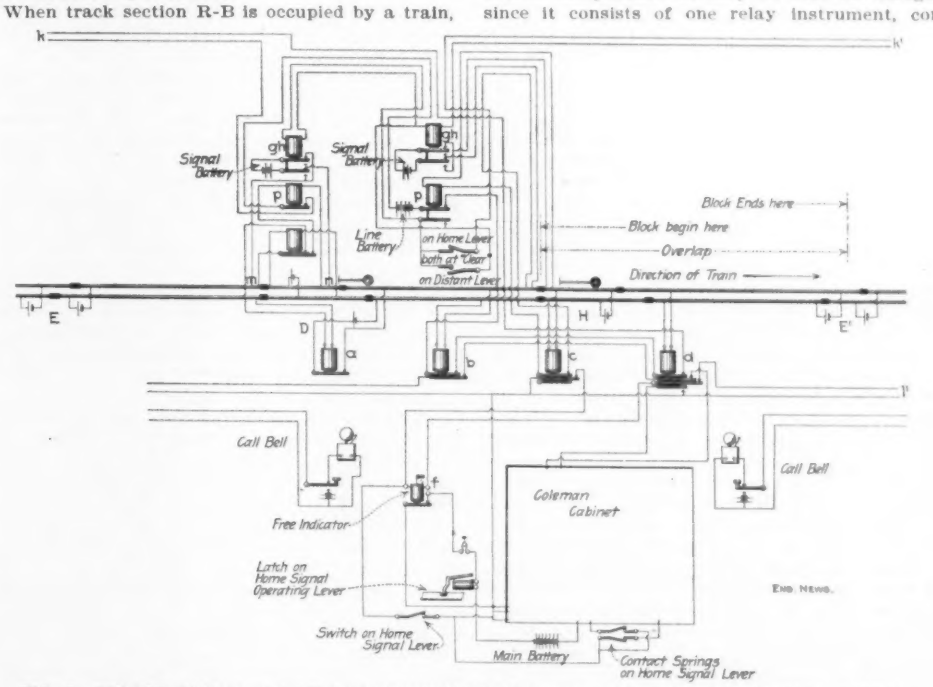


FIG. 3. MILLER SIGNAL SYSTEM IN CONJUNCTION WITH CONTROLLED MANUAL SIGNAL MECHANISM; PARK AVE. TUNNEL OF THE N. Y. C. & H. R. R. R.

To enable the new signal equipment to be understood, a short reference to the previously existing equipment is necessary. On account of its complexity only the more essential portions of this are indicated in our drawing. It constitutes a "controlled manual" system, i. e., one in which the signals are set by hand, but on information given by an automatic track-circuit system, the setting of the signals being further under control of automatic locking circuits connecting the signal levers with the indicating instruments.

In Fig. 3 portions of two block lengths are shown by the length of track E-E'. The location of distant and home signal is indicated by D and H. One block begins at the home signal point H, extending thence to the right; the preceding block, to the left, extends from the preceding home station to point E'. The distance H-E' is thus part of two blocks which overlap, and this distance is, in fact, called the "overlap;" its length is about 800 ft. on the average.

The old equipment includes four relay magnets, for each. Beginning at the left, magnet (a) is a detector for track section E D, and if this is clear, the magnet connects a battery into section D H. Magnet (b) is then a detector for the section of

track from E to H. Magnet (d) acts similarly for section H-E'. When (b) and (d) both indicate "Clear," i. e., attract their armatures, then by circuits through their armature contacts they cause a movable drop in the Coleman Cabinet (a complex indicating instrument not shown in detail in our drawing) to show "block free," which tells the operator that the entire block preceding his station is clear. By way of line wires (l) this indication is shown at the preceding station by actuating the "free indicator" (f); but the current first passes through armature of magnet (d) at that station, and thus the free indicator is made to depend on the entire block from one home station to the next, plus the overlap H-E'.

There are several other instruments in each signal station besides those shown in our drawing, but further reference to this installation of controlled manual signal system is unnecessary in the present article. It is desired merely to point out how the Miller signals were superimposed on this existing equipment without interfering with its independent working.

The old track relay magnets (shown below the track) were utilized for the track indications by adding extra armature contacts where necessary. The impulses for the "Miller" engine cab indications are given at the distant and the home signal points. The same pair of lamps (red and white) is used at both signaling points, the two signals being considered merely as two repetitions of the same signal.

The signaling relays, or reversing keys, corresponding to magnets (g) of Fig. 1, are here marked (g d) and (g h), at distant and home stations, respectively. They are actuated by current from two line wires (k') leading from the following station, depending upon the condition of the entire block lying between those two stations, plus the overlap. Correspondingly, the indications from the track relays (a), (b), (c) and (d), are sent back over the line wires (k) to the preceding station, and actuate the signaling magnets there.

The points at which the signaling batteries are connected to the track rail are marked (m) and (n), just as in Fig. 1. In the Park Ave. installation it was considered especially important to have a check on the proper connection of the signal batteries to the track, i. e., to know when these batteries are out of order or otherwise not in action. This check is obtained by making the proper connection of these batteries a condition precedent to sending a "Clear" signal to the preceding station. The proof magnets marked (p) operate to this effect; their windings connect with taps taken off the track rails directly adjacent to points (m) and (n), so that the proof magnets are energized only when (g d) or (g h), respectively, connect their signal batteries to the track, and when these batteries are in proper active condition. The armatures of the proof magnets are directly in the main line wire circuit leading back to the preceding station, and they "make" or close this circuit only when the signaling batteries "prove" in order. Thus, if either of the two signaling batteries or its connection to the track is out of order, the Miller signals give a red signal one block to the rear.

Just below the home relay magnets in Fig. 3 will be seen a representation of two switches, marked "On Home Lever" and "On Distant Lever," respectively. If the connections of these switches be followed out, it will be seen that the arrangement is such that the Miller signals are always at "Danger," when the old or track signals are at "Danger," while when the latter are "Clear" the Miller signals go to "Clear" only if the following block is actually unoccupied. It must be remembered that the old manual system gives no guarantee that signals and track conditions correspond; a train may pass a "Clear" signal, and the signal operator fail to set his signals to "Danger," or, again, a slight derangement of the complex indicating mechanism may destroy all relation between the track conditions and the setting of the signals. On the other hand, the Miller signals should go to "Danger" with the track signals, even though the track be clear, in order to preserve the "manual" character of the signals; it may be desired to set a signal against a train even with clear track, or to operate the line entirely by orders, and the manual system makes this possible by making the signal setting partly independent of the track conditions.

The pair of switches shown has the further object of making the signaling relays (g h) and (g d), at home and distant stations, independent, though normally operating together. Normally the line circuit from (k') passes through (g h) and is shunted through (g d). When the home lever is at "Danger," then both circuots are broken, and the Miller indication at both distant and home points is red. But when the home lever is clear while the distant lever is at danger, then the magnet (g d) is cut out of circuit, so that the Miller signal at D is red, though that at H may be "Clear."

The preceding explanation will enable the circuits of the Miller signals in Fig. 3 to be followed out in detail. It will be noted that their proper operation is safeguarded at every possible point, against derangements of the old signals with which they work, as well as against accidental failure of the Miller apparatus itself. At all possible points of failure the arrangement is such that a red or "Danger" (more properly "Caution") signal results from the failure of any element of the system. The necessity for this might appear in the case of any piece of railway track; but it is made much more urgent in the case of the Park Ave. tunnel by the phenomenally dense traffic and the bad operating conditions there, for which the tunnel is deservedly notorious.

Moreover, it should be borne in mind that these signals were added to what was already an unusually complex aggregation of signals. There are distant signals (green, for caution, white for clear), and home signals (red for danger, white for clear), the latter in duplicate, at two different levels; at each home signal point are torpedo machines, in duplicate, which set torpedoes when the signal is turned to red, to be exploded by a passing train, and at the same point is a large gong which rings when a train passes a red signal. It was therefore essential, in putting in the Miller signals, to work together with the existing signals as far as this was safe, but to maintain every precaution, that the cab signal indications might be a safe guide to the engine-runner in every emergency, even though the old signals should fail or be set wrong.

The Park Ave. tunnel installation, as far as it has been used up to the present, has been entirely successful. The line has been equipped from the Grand Central station, or rather from the northerly end of the station yard, at 56th St., as far north as 110th St., just above the end of the tunnel. Work is at present under way extending the system to the Harlem River swing bridge, at 139th St. Less than a dozen locomotives have been equipped for Miller signals up to the present, these being principally of the New York Central's new suburban type of engines.

The engine-cab method of signaling is controlled by the Miller Signal Co., of Chicago, Ill.; of this company, Mr. H. V. Miller is President, Mr. G. M. Bates, Secretary, and Mr. A. C. Miller, General Manager. Messrs. H. V. and A. C. Miller are the inventors of the method. Mr. J. D. Price, as Signal Engineer for the company, worked out the application of the system to different cases and designed the instruments used. In particular, he has supervised the installation of the Miller signals in the Park Ave. tunnel, carrying out a successful piece of work under many difficulties and discouragements.

PROPOSED RULES TO GOVERN THE STORAGE AND USE OF EXPLOSIVES IN NEW YORK CITY.

As a result of the disastrous explosion of dynamite, on Jan. 27 last, in the Rapid Transit tunnel, which partly wrecked the Murray Hill Hotel and caused the death of several men, a Municipal Explosives Commission was appointed by Mayor Seth Low last spring. This commission, of which Gen. George O. Eaton is chairman, has formulated a very complete report embodying rules for the handling and storing of explosives, with especial reference to dynamite.

On December 11, a final oral hearing was given that any suggestions or objections to the rules proposed by the commission might be presented. The contractors of the city had engaged an attorney, who for some reason was unable to be present to represent his clients. The commission, however, agreed to consider any brief submitted before the end of the week.

Several of the large manufacturers of dynamite had representatives present who offered certain objections to minor points, but the main reason for their presence was evidently to oppose any effort of the so-called safety powder manufacturers who were there to urge that their powders be exempted from certain rules of the commission.

In behalf of one dynamite company, Mr. Frederick Julian said that he had been the first man to fire a dynamite shot in New York city; and that although he had handled dynamite for 30 years, neither he nor any of his men had ever had a single accident. He had repeatedly pounded sticks of dynamite to pieces using an iron maul, without any explosion. On one occasion a case of dynamite was fastened to a freight car buffer, and another car allowed to run against it by gravity. The result was simply to smash the sticks of dynamite into small fragments. He had heard of many freight wrecks, but never of a single explosion of dynamite in the wrecked cars.

Accounts of accidental ignition of dynamite, and of great shocks suffered by blows, were given by others, all to show that explosions did not occur.

Mr. H. P. Gillette said that experiences of his own had convinced him that dynamite will not explode by shock or upon ignition so long as the nitroglycerine remains in the absorbent dope; but in thawing frozen sticks the nitroglycerine may ooze out between the folds of the paper and then dropping even a few inches this nitroglycerine will explode. He cited an instance where he was holding a stick over a stove to thaw it. A drop of nitroglycerine fell from the stick a distance of about six inches, and striking the stove exploded like a pistol shot. The stove was cracked, and red hot coal fell upon dynamite lying in the oven, which was set on fire but did not explode. Had the drop of nitroglycerine been a trifle closer to the stick of dynamite when it exploded there is not the slightest doubt that it would have set the stick off by its detonating effect.

Representatives of two safety powders, Jovelite and Masurite, made a strong plea for an examination and test of their respective powders by the commission, arguing that they could convince the commission that they have powders infinitely safer than dynamite, and powders that never freeze. It was stated that pistol shots had been fired into these powders and blows of great violence had been given, without exploding them. It was claimed that a detonator which would explode these powders when tamped in a hole, would not explode them when placed in a loose mass of the powder and fired; and emphasis was laid upon the fact that these powders do not freeze.

The commission, while not denying the truth of the claims for these safety powders, seemed inclined to make no change in their rules, classing all powders alike under the one head of "explosives," to which the rules apply. They held that time alone could determine the merits of these powders, and that they as a commission could not discriminate in favor of or against any powder.

We give the most important features of these rules as follows:

For manufacturers, agents and all others who desire to bring explosives as designated in Sec. 763 of the charter (as amended) and sell the same, a bond in the penal sum of $5,000, and in case of said delivery being by wagons, an additional sum of $5,000, for each and every wagon in excess of one wagon engaged within the city in the delivery of said explosives as provided for herein.

For all contractors and others now engaged in or proposing hereafter to engage in any blasting operations, a bond in one of the following classes:

1. For the right to use or have on hand in any one day explosives not exceeding 50 lbs., $5,000.
2. For the right to use or have on hand in any one day explosives not exceeding 100 lbs., $10,000.
3. For the right to use or have on hand in any one day explosives not exceeding 250 lbs., $15,000.
4. For the right to use or have on hand in any one day explosives not exceeding 500 lbs., $20,000.
5. For the right to use or have on hand in any one day explosives in excess of 500 lbs., $25,000.

For venders of small quantities at retail as provided for herein, a bond of $5,000.

TRANSPORTATION.

(1) Pure nitroglycerine, or nitroglycerine in any form of

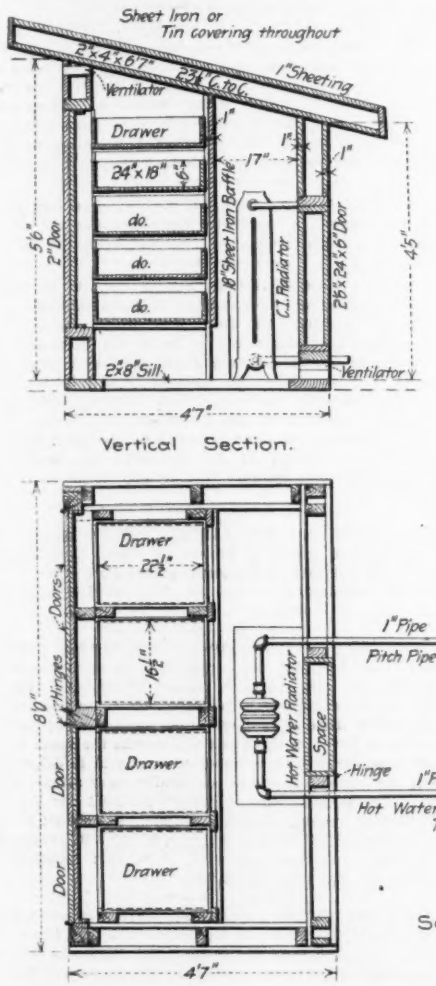
solution other than the official U. S. Pharmacopœia solution, shall not be transported through the city of New York.

(2) Guncotton used in the arts in amount not exceeding 10 lbs., dry weight, and containing at least an equal weight of water may be transported in charge of a duly certified employe of a licensee.

(3) No explosives shall be transported by wagon through the streets of the city of New York unless said wagon is in charge of a competent person holding a certificate of fitness to transport, from the fire commissioner, which certificate shall be open to inspection by any inspector of combustibles or police officer. Said certificates of fitness shall be issued only to employees of corporations, firms or persons duly licensed by the fire commissioner to transport or sell explosives in the city of New York.

(4) A wagon used for the transportation of explosives shall be in good condition for service.

(5) A wagon used for transportation of explosives after Jan. 1, 1903, shall comply with the following specifications. It shall have:



DYNAMITE THAWING HOUSE.

(a) Springs.

(b) A wooden top extending over bed enclosed on both sides and back.

(c) An additional floor laid lengthwise of sound material not exceeding 3 ins. wide, tongued and grooved, planed smooth and fair and blind nailed.

(6) No metal tools or other pieces of metal shall be carried within the wagon.

(7) No exploders or other combustible material, except so-called safety fuse in carefully-sealed package shall be transported in the same vehicle with explosives.

(8) Not more than 1,000 lbs. of explosives shall be transported on a wagon through the streets of New York city.

(9) A wagon carrying explosives shall be drawn by a horse or horses amply able to draw the load and avoid stoppages other than to load and unload, and no unnecessary stops shall be made.

(01 No explosives shall be left on a wagon unless said wagon is in charge of an employee with certificate of fitness, and no driver shall leave a wagon loaded with explosives unattended in the city of New York.

(11) A wagon carrying explosives shall have painted on it in black letters at least six inches high "Powder Wagon" on sides and back, and shall also have the owner's name displayed so as to be easily read a distance of 100 ft. on each side, and in case of a licensee having more than one wagon they shall be plainly lettered "Wagon No. 1," or "No. 2," etc.

(12) A wagon carrying explosives shall avoid whenever possible those streets on which there is a large number of persons.

(13) The presence or interference of unauthorized persons during unloading, loading or transportation shall not be allowed.

(14) Carelessness or recklessness in conducting or during loading or unloading of a vehicle carrying explosives shall not be permitted.

(15) No intoxicated person shall be permitted on a vehicle carrying explosives.

(16) Smoking within 10 ft. of a wagon loaded with explosives shall not be permitted.

(17) Explosives transported through the city of New York shall be packed as follows:

(a) Dynamite or Other Blasting Compounds.—In strong wooden cases, containing not more than 50 lbs. of explosive, and lined with a liquid-proof paper lining, sufficient to prevent liquid from going through the sides or bottom of the case.

(b) Black Blasting Powder.—In sound wooden, fiber or metal kegs containing not more than 25 lbs.

(c) Black and Smokeless Sporting Powder.—In sound wooden, fiber or metal kegs or canisters, containing not more than 25 lbs. each.

(d) Military Smokeless Powder.—In sound wood or metal packages containing not more than 125 lbs. each.

(18) Each package containing explosives must have the name and brand of manufacturer, and if packed in a wooden case, must be marked on sides "Explosive—Dangerous."

BLASTING.

(1) No person shall direct any blasting operation, or handle explosives, except a holder of certificate of fitness as described under Article III. of these regulations.

(2) Explosives that are frozen or partly frozen shall not be placed in drill holes. Frozen cartridges, if not capped, must be returned to the original magazine to be thawed; if capped, they shall be placed only in a magazine of the third class by themselves. If necessary to remove the cap or detonator from any cartridge, care must be exercised in so doing.

(3) In tamping drill holes, only wooden rammers shall be used, and tamping by strokes is forbidden, and only pressure permitted. Only one primer shall be used in a drill hole, and great care shall be exercised in placing it in the drill hole and while tamping above and around it.

(4) Blasts shall be fired by some form of electrical apparatus only; the use of time-fuse blasts being forbidden. In the event of the charge not exploding, it is forbidden to remove the tamping, and if the charge cannot be fired by exploding a stronger primer on top of it, a new hole shall be drilled not nearer than 12 ins. from the first one and another charge put in the second hole and fired. In the case of an explosion not carying away the whole of the drill hole, but leaving the lower part intact, it is forbidden to begin drilling from the bottom of the old drill hole, as portions of the former charge may remain and explode when exposed to the blows of the drill.

(5) In order to insure the safety of surrounding property and persons, no larger charge shall be used than is necessary to properly start the rock, and rock excavation contiguous to any structure shall be so carried on as not to cause damage to such structure. To this end, weak walls, or other supports of such structures, must be shored-up, and rotten or decomposed rock must be removed by the use of gads, picks and crowbars only. When blasting next to such structure is unavoidable, light-face blasts only, with short lines of resistance and small charges, shall be used.

(6) The quantity of explosives to be used shall not exceed in disruptive force the equivalent in 1 lb. in weight of 50% dynamite for each 4 ft. depth of hole that is above, or less than 10 ft. below the curb; and the equivalent of 1 lb. in weight of 60% dynamite for each 4 ft. depth of hole that is more than 10 ft. below the curb.

(7) Before firing any blasts, except where the same are in tunnel and distant from the face or portal more than 50 ft., the rock to be blasted shall be covered on the top and sides with timber at least 10 ins. smallest diameter and 10 ft. long, held together at each end by chains or ropes of iron or steel ¾-in. in diameter, and covered with sheets of tin or stout woven matting of rope, or some other equally serviceable material to prevent the debris from flying.

(8) Red flags shall be placed at reasonable distances from the blasts on all sides in the hands of competent men to give all persons proper warning at least three minutes in advance of the blasts.

PRECAUTIONS.

The careful handling of all explosives, whether frozen or not frozen, is ordered.

Nitroglycerine is very sensitive at a temperature exceeding 300° Fahrenheit and at 350° is liable to explode spontaneously.

Nitroglycerine compounds are sensitive to moisture, and the ordinary absorbent bases have a tendency to absorb moisture, by which absorption there is displaced and set free an equivalent amount of nitroglycerine. Therefore, magazines must be kept dry and all moisture kept away from the explosives. For the above reasons the ordinary forms of warming or thawing explosives by placing the same near fire or against steam pipes or in water are exceedingly dangerous and are therefore prohibited.

In the keeping of explosives from freezing or in thawing of the same when frozen, only one of two methods shall be permitted: first, by some form of hot-water heater where it is impossible for the maximum degree of heat to exceed the temperature of boiling water; or, second, the burying of the receptacles containing explosives in manure. All other methods are absolutely forbidden, except after specific approvel in each case by the Municipal Explosives Commission.

Caps, detonators or other similar explosives of a high order shall not be brought within 20 ft. of the magazine, and each licensee must provide a proper receptacle for said caps and detonators

Cartridges while being capped shall be removed from the magazine for a distance, if possible, of 50 ft., but in no event less than 20 ft., and after being capped shall not be returned to the magazine. If required to be kept from freezing they shall be kept in a special magazine of the third class in as small amount as possible. Cartridges shall be capped only as required for the work and for immediate use.

The foregoing, as stated before, form but a part of the many rules laid down by the commission. The commission specifies in detail a form of magazine for storing dynamite in New York city.

This magazine, or thawing-house, is shown in the accompanying cut, and is designed to hold 500 lbs. of dynamite. A feature of the design that merits praise is the arrangement of the drawers immediately back of folding doors, leaving no place for a man to stand inside the magazine; and making unnecessary the use of any form of artificial light in handling the dynamite. It will be remembered that the disastrous Park Ave. explosion was said to have been caused by a lighted candle in the magazine. The candle fell to the floor, ignited some paper, and the explosion followed.

The commission has had a powder house built according to plans here shown at a cost of $200. The powder house is on exhibition at the Fire Dept. headquarters, at 157 East 67th St.

SELF-CLEANING AND CINDER-CATCHING SMOKE-BOXES ON LOCOMOTIVES.

When the extension front smokebox was first introduced the intention was that it should retain the cinders to a large extent, and cinder hoppers were provided for cleaning out the accumulation. At the present time, however, there seems to be a very general opinion that the smokebox should be "self-cleaning," the sparks and cinders being discharged from the smokestack, but being first broken up so that they will not be liable to cause fires.

At the November meeting of the Western Railway Club, Mr. Frank Slater, Master Mechanic of the Chicago & Northwestern Ry., at Escanaba, Mich., read a paper on "Self-Cleaning Locomotive Front Ends," in which he advocated this type of extension front smokebox, and described two arrangements of diaphragms and netting which he has introduced in order to prevent the accumulation of cinders in the smokebox. These are illustrated herewith. In either case the diaphragm behind the blast pipe must be extended quite low or the tubes will be liable to choke. The dia-

phragm in front of the pipe must also be extended well ahead of the pipe. He preferred the arrangement shown in Fig. 2, as it is found to throw even less sparks than the other. This is no doubt due to the fact that the draft from the tube is not simply choked or throttled by an inclined diaphragm, as in Fig. 1, but strikes a vertical baffle plate, causing the current to be broken up and the cinders churned around and broken before they are finally blown out. Some extracts from Mr. Slater's paper are given below:

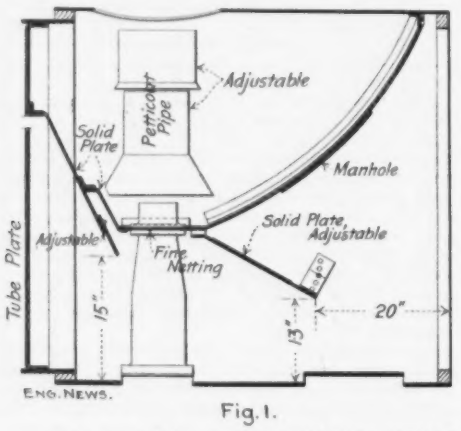


Fig. 1.

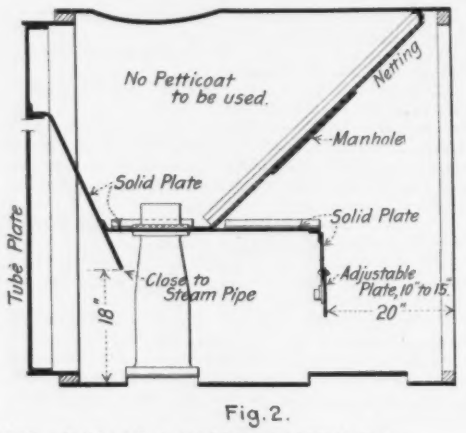


Fig. 2.

FIGS. 1 AND 2. SELF-CLEANING SMOKEBOXES; CHICAGO & NORTHWESTERN RY.

It has been the opinion of practically all railroad men, that an extension front is an absolute necessity, in order to prevent causing fires; but in my opinion this is a mistake. I have made very careful observations and find that in nearly all cases cinders accumulate very rapidly until they have reached a certain height, depending entirely upon the front end arrangement. The front end then becomes self-cleaning. No more fires are caused after it is in this condition than when it is perfectly clean.

Master mechanics and roundhouse foremen must agree that it is a difficult matter to keep the door joint on the boiler front air tight, as well as the joints on the cinder hopper. Any slight leak will allow the hot cinders to burn, thereby warping and cracking the front end, which is very expensive, as well as giving the engine a very bad appearance. It seems to me, therefore, that a self-cleaning front end would be the most economical, and would give the same protection against fires that the extension front end does.

Some years ago it was the custom on many roads to clean the front ends of locomotives at several places on the division over which the engine was passing. This practice has practically died out, and engines are now expected to pass over the entire division without cleaning the front ends. Thus, when in starting out on a run the engine is equipped with a spark retaining front end, it soon converts itself into a self-cleaner.

I have experimented a little for the purpose of finding a front end arrangement that could be applied to the extension ends in use, which would be self-cleaning and do away with the accumulating of cinders back of the steam pipes and exhaust pipes, and at the same time so distribute the draft through the flues that all flues will remain clean. The front end shown in Fig. 1, has a table plate made of perforated steel. The ordinary diaphragm back of the steam pipes is adjusted to distribute the draft through the flues uniformly, and should be set as high as possible without allowing the cinders to accumulate around the bottom of the steam pipes or back of the exhaust nozzle.

The front diaphragm or baffle plate is used for the purpose of carrying the draft far enough ahead to make the front end self-cleaning. A perforated table plate is used for the purpose of preventing an accumulation of cinders on top of it. In practice enough draft will pass up through this table plate to keep it clean, but the major portion of the draft will pass ahead and under the front baffle plate, thus keeping the front free from cinders. The advantage in using this device is that it affords ample netting area to reduce the velocity of the cinders, and in this way allow cinders to be churned around the front end a sufficient number of times to extinguish them and pulverize them, throwing them out harmless. It is my opinion, however, that locomotive front ends with this device can be shortened considerably, as no cinder hopper will be required; but I have not conducted any experiments for the purpose of determining just how short the front end can be made and give the engine a sufficient amount of netting for free steaming. It will also be noticed that the front end has a petticoat pipe.

The front end shown in Fig. 2 differs quite considerably from that in Fig. 1. The back diaphragm is without a movable apron, and is set at a height which has been found by experiment to prevent the accumulation of cinders. This experiment should be made on an engine with a movable apron, and when the height is found (on engines of any given class), a solid plate can be used which will reduce the cost, as well as avoid the expense of adjustment.

On the engine experimented with it was found that 18 ins. was as low as was necessary to keep cinders from accumulating back of the steam pipes and exhaust pipes, also low enough to prevent the lower flues from stopping up. The table plate is extended to within 20 ins. of the front end, and the front diaphragm or baffle plate is vertical instead of inclined, as in Fig. 1. The adjustment of this diaphragm will enable the front end to be kept practically free from cinders. It will also be seen that no petticoat is used, which simplifies the front end very much. The solid table plate, however, allows an accumulation of cinders on the top of the plate, which does no harm. The netting is brought back as close as possible to the exhaust nozzle, thus giving the greatest possible amount of netting. Both styles of front ends are giving very good service.

It may be desirable to have passenger engines equipped with an extended front end which will deposit a large number of the cinders in the smoke arch, for the comfort of passengers; but there are a great many engines built for switching purposes and freight service which will never be used in passenger service. On engines of this build, a self-cleaning front end, so arranged that live sparks of a size which will set fire cannot escape, will certainly be a more serviceable and profitable front end arrangement than the present extension fronts intended to collect cinders.

I have tried a great many times to dispense with the use of the petticoat pipe, for the reason that the simpler a front end can be made the more easily it can be adjusted to do its maximum work, but I find it requires a smaller nozzle without a petticoat. In addition to this, on engines having low exhaust nozzles, as is the customary practice at this time, the blower has not the same effect upon the fire that it will have when a petticoat is used. It therefore requires a greater length of tmie to get up steam when the engine is being fired up than it does when a petticoat is used; and also the blower must be applied very much stronger without a petticoat than with one, when it is intended to check black smoke, when engines are standing at stations. Should the steam pressure from any cause become lowered, and it is desired to force the fire with a blower, the engines without the petticoat will be found to be very much slower in generating steam.

No two superintendents of motive power, master mechanics or roundhouse foremen, or even enginemen, will agree on a front end. Two neighboring roads running through the same section of country, using the same grade of fuel, cannot (at least, so it is claimed) use the same front end. In fact, it is safe to say that the different master mechanics on the same road will hardly agree on a front end. Each one of them has some idea of a front end that is just a little different from the others and which he thinks is superior. The differences between the different front ends, in many cases, are so slight that it does not seem sensible to have this difference exist, but it does exist, and will so long as there are locomotives and master mechanics in charge of them.

In the discussion, Mr. Peck (Chicago & Western Indiana R. R.) said that on his line, which does a switching business in the city, the diamond stack was replaced by the cinder-catching extension front end, but this soon filled up, and the cinders were then thrown out. He now uses a self-cleaning front end. The good results are partly due to a peculiar form of nozzle, whose diameter is reduced from 5 ins. to 4¾ ins., a little below the top. He doubted whether the arrangement of netting and deflectors in the smokebox really has much effect upon fuel consumption, but Mr. Wilson (Chicago, Rock Island & Pacific Ry.) thought the consumption was greater with a self-cleaning front end. Mr. Manchester (Chicago, Milwaukee & St. Paul Ry.) did not approve of the self-cleaning smokebox, but advised that more attention should be given to means for keeping cinders on the firebox. Mr. Tratman (Engineering News) thought that the great variation in results with different front-end arrangements, and the high efficiency claimed for certain of these arrangements, are due largely to the element of personal prejudice, no real or reliable comparative tests being usually made. Mr. J. Snowden Bell, of Philadelphia, sent a written discussion, strongly condemning the extension smokebox, and referring to the engines of the Lake Shore & Michigan Southern Ry., in which the end of the smokebox is only 28 or 30 ins. from the center of the nozzle.

A NOVEL METHOD OF THAWING DYNAMITE was tried by two miners at Ruby, Colo., the other day. They cut one end out of an empty powder can, made holes with a pick point in the other end, and placed the can over a lamp. Three sticks of "giant" were then laid on top of the can. In a few minutes a forcible demonstration of some objectionable features of the invention occurred. Both miners are reported to have a chance of recovery.

A DAM FAILED NEAR BUFFALO, COLO., on Dec. 5. It was located in the Platte Canyon, above Denver, and appears to have been owned by the Bosler Ice Co.

WORLD'S CONGRESSES are to be held at the St. Louis Exposition, as was done at Paris in 1900 and at Chicago in 1893. Mr. Howard J. Rogers, Chief of the Department of Education, is to be the Director of the Congresses and an Advisory Board has been created, made up as follows: Chairman, Nicholas Murray Butler, President of Columbia University, New York city; William R. Harper, President of the University of Chicago; R. H. Jesse, President of the University of Missouri; Henry S. Pritchett, President of the Massachusetts Institute of Technology, and Herbert B. Putnam, Librarian of Congress.

ANOTHER BIG SIX-MASTED SCHOONER is to be built for the syndicate headed by Capt. J. G. Crowley. The keel was laid at the yards of the Fore River Ship & Engine Building Co. on Dec. 9. The vessel is to be called the "Wm. L. Douglas."

THE IMPORTATIONS OF MANUFACTURES OF IRON and steel, for 1902, are larger than at any time in the last decade, says the U. S. Bureau of Statistics. For the ten months ending with October, 1902, these importations are double those of 1901, and three times those of the same period in 1900. In these last ten months the value of iron and steel manufactures imported amounted to $31,987,056, and the increase shows in practically every article in this list. The largest items of imports for 1902 are: Pig iron, $7,272,913; ingots, blooms, bars, etc., $6,242,609; tin and terne plate, $3,329,333; machinery, $3,427,159; cutlery, $1,421,852; scrap iron and steel, $1,262,784; railway bars, $1,226,824; bar iron, $1,032,834.

MANUFACTURES FORM ONE-THIRD of our exports, says the U. S. Bureau of Statistics. This is a larger proportion than in any preceding year; 1900 was the next best year with 31.05%, as against 32.61% for the first ten months of the present year. On the basis of these ten months the total exports of manufactures for 1902 will amount to about $415,000,000. The annual value of exports did not reach $100,000,000 until 1877, $200,000,000 until 1896; in 1899 it exceeded $300,000,000, and in 1900 it reached the $400,000,000 mark. The Bureau states that over one-half of our exported manufactures go to Europe, one-fourth to North America, and the other one-fourth is about equally distributed between South America, Asia, Oceanica and Africa. Four great articles of manufacture exported to Europe—copper, mineral oil and iron and steel manufactures—each exceed $40,000,000 in value; leather exports exceed $20,000,000 and agricultural implements $10,000,000.

MUNICIPAL OWNERSHIP AND OPERATION of the street railway system of St. Thomas, Ont., was begun on Nov. 25. In 1898, the city guaranteed $50,000 of bonds of the St. Thomas Street Railway Co., taking a mortgage to that amount on the franchise and property of the company. The company failed to meet its obligations to the city, so under the terms of the mortgage the road, equipment, and franchise has become the property of the city. Changes and extensions will be made next year. Mr. Jas. A. Bell is city engineer of St. Thomas, and we are indebted to him for the information given.

SNOW REMOVAL IN NEW YORK CITY this winter is to cost only 25 cts. per cu. yd., as compared with 40 cts. last winter. The new contract has just been awarded to Mr. Wm. Bradley.

ENGINEERING LITERATURE

M. N. Baker, Editor

Supplement to ENGINEERING NEWS

Thursday, December 18, 1902

CONTENTS.

EDITORIAL:

Explanatory Statement.—The New Trautwine.—Engineering Literature 1

CORRESPONDENCE:

Books on Tunneling.—Literature on Municipal Charters..... 1

REVIEWS:

The Story of the Erie Railroad..... 2
Two Books on Aerial Navigation..... 3
An Encyclopedic Dictionary for Architects and Engineers..... 3
A Treatise on Mechanical Refrigeration and Its Applications..... 4
Municipal Activities, Finances, and Organization; Ancient, Medieval and Modern... 5
Sanitary Legislation and Practice, Chiefly with Reference to Boards of Health..... 5
Forestry for Beginners 5
Two Books on Electrical Engineering..... 6
How to Construct Dies and How to Use Power Presses 6
Pathogenic Bacteria and the Soil..... 7
Parallel Tables of Logarithms and Squares of Feet, Inches and Fractions of Inches... 7
Five Hundred Problems for Students of Mechanics..... 7
A Reference Library of Modern Engineering. 8
The Analysis of Iron and Steel and the Materials Used in Their Production..... 8
A Systematic Attempt to Teach Metallurgy by the Laboratory Method..... 8
How to Test Coals and Oils, Illuminating Gas and Its By-Products..... 8
A Semi-Popular English Book on the Sanitary Aspects of Water Supplies..... 9
The Foundations of Geometry..... 9
General Specifications for Foundations and Substructures of Highway and Electric Railway Bridges..... 9
Materials of Machines..... 9
The Cost of Production..... 9
Induction Coils 10
Worm and Spiral Gearing..... 10
A Classified List of Minerals, Precious and Other Stones..... 10
The Health Officers' Manual and Public Health Law of the State of New York.... 10
Report of and Reprints from the Massachusetts State Board of Health..... 10
Coal Number of the Indian Mercury..... 10
Mosquito Extermination on Long Island.... 11
Ground Water; A Colorado Soil Study..... 11
The River-Irrigating Waters of Arizona.... 11
Proceedings of Convention of Weather Officials..... 11
Digest of Governor's Messages..... 11
Sewage Purification Plants..... 11
The Current Literary Magazines..... 11
Publications Received..... 12

Lest either the facts or our motives should be misunderstood, we wish to state that the size of the present number of this supplement is no assurance of the amount of space to be devoted to Engineering Literature in successive issues. In general, it may be stated that our aim will be promptness in noticing all publications which we think will appeal to our readers, rather than the maintenance of any fixed standard of size. Preliminary acknowledgments of publications received in the interval between issues of the supplement may be expected in the intervening weekly issues of Engineering News.

Perhaps no announcement pertinent to these columns could be made that would interest more readers than the fact that a new and extensively revised edition of Trautwine's "Civil Engineers' Pocket-Book" has just been published. The revision has been made by the son and grandson of the late Mr. Trautwine, and will receive more extended notice in the next issue of this supplement. We take this opportunity to add that some other new books, not reviewed in this issue, are announced, together with their size, price and publishers, elsewhere in this issue. These will be noticed at proper length in a later issue.

Engineering Literature.

Books and other publications relating to engineering, the allied arts and sciences, and various public questions of the day are coming from the press so rapidly, and the demand for critical estimates of their value is so great, that it seems desirable to give them more extended, prompt, and systematic attention than is possible in the crowded columns of the main sheet of Engineering News. Accordingly it has been decided to issue a supplement devoted entirely to Engineering Literature.

Under the title named we propose to cover not only the several branches of engineering and the various arts and sciences related thereto, but also such phases of economics, sociology, municipal administration, public art, exploration, travel, biography, and history as appeal particularly to the readers of Engineering News. This supplement will be published with an issue of Engineering News about the middle of each month, and all subjects requiring more prompt attention will continue to receive it in our regular weekly issue.

The supplement will include reviews and critical notes, announcements of new and forthcoming publications, letters from readers, answers to inquiries, and editorial comments and discussions. Its aim will be to convey prompt and critical information regarding the class of literature already mentioned, and to raise the technical and literary standards of all such publications.

The primary object of the book reviews will be to aid interested persons in deciding whether or not it is worth while to add a given new book to their library. To this end an attempt will be made to give a comprehensive idea of the contents of each volume reviewed, and to indicate its value as a contribution to the literature of the particular subject involved. Such an estimate demands a consideration of the character and scope of each book, both independently and in its relation to other works on the same subject. A possible purchaser who has no book on the subject treated wants to know how complete and authoritative the latest publication is, and in what respect it is superior or inferior to others covering the same field. The man with a well-stocked library, on the other hand, wishes to be informed whether it is worth while to add the new volume to his collection.

Next in importance to conveying an idea of the contents of a book and their relation to other publications is the consideration of the way in which the subject matter has been presented. This includes both the arrangement of the several parts in relation to each other and the clearness and general style of the language employed. In other words, literary excellence is an essential quality to the best technical, as well as other, writing. This fact has been altogether too generally ignored in the past, but must be borne in mind hereafter by both authors and publishers. In fact, some of the latter are already insisting upon it, as not a few authors have found to their sorrow.

Letters criticising engineering literature, with a view to improving its quality, will be welcomed in the columns of the supplement. In fact, it is hoped that they may become one of its most valuable features, since the opinions of those who have read or used a book ought to show both its faults and its merits, and thus serve as a most valuable guide to authors and publishers.

The inquiries and answers thereto which are published in the supplement will necessarily be limited to information not generally known or readily available, and which bids fair to be of interest or value to others besides the inquirers.

Editorial comments and discussions will naturally relate to various topics suggested by books under review, and it is hoped that they, like the letters from readers, may also include criticisms of literature both old and new, and particularly references to the gaps in engineering literature. That there are many such gaps engineers well know. Doubtless they would be filled more rapidly if only their presence were more frequently and strongly emphasized by discriminating readers and editors. On the other hand, some fields are already so well covered that it would be well if authors could be directed elsewhere.

Some of the advantages which we trust will result from the publication of this supplement, as compared with our previous efforts to deal with engineering literature, are more space for book reviews, a wider range of topics covered, increased care in the preparation of reviews, and the virtual addition of two new features: Letters from the readers and users of books, and editorial surveys of engineering literature.

Finally, we hope that with the cooperation of the readers of the supplement and of both authors and publishers, we may eventually do for engineering and other technical books what the best of the literary weeklies and monthlies are doing so well for general literature, thus contributing somewhat to the advance of engineering and the allied arts and sciences, and to the sound development of the literature thereof.

CORRESPONDENCE.

Books on Tunneling.

Sir: Will you kindly favor me with a list of five standard works on Tunnels (English)?

C. K. Conard,
Asst. Engr. B. & O. R. R. Co.

Dividing Ridge, Somerset Co., Pa., Dec. 2, 1902.

(We doubt if it be possible without some strain on the truth to name five books on tunneling which will meet fully our correspondent's specifications. Strange as it may seem in this day of many books for engineers there are at most only four treating on general tunnel work in the English language, which by any chance fulfill the requirements of even so elastic a term as "standard" has become when applied to the definition of a book on an engineering subject. The first name which naturally occurs to an American engineer, when asked for the title of an authoritative treatise on tunnels, is Drinker's "Tunneling, Explosive Compounds and Rock Drills," or, more familiarly, "Drinker." This work contains a wealth of information on tunneling as practiced prior to 1875, which is nowhere surpassed. Unfortunately, however, it is a book which is not generally available. There are, we believe, more copies yet for sale, but as the work is not to be reprinted its possession is beyond the reach of all but a few, even of those who feel able to spend $25 on a single book for their professional libraries. Next to Drinker in age and honorable memory is Simms' "Practical Tunneling" ($12). This is an excellent exposition of the so-called "English method" of soft-ground tunneling, and as edited and revised by D. Kinnear Clark it gives much information, in a somewhat random fashion, on tunneling processes in general. Another British book of note is Gripper's "Tunneling Through Heavy Ground" ($3), but its scope is still more limited than that of Simms' and in general usefulness it is far inferior to either Simms' or Drinker's works. The fourth book which solicits the atention of the engineer is Prelini's "Tunneling" ($3), published in 1901. This is an attempt to improve on the books previously named by giving a general and up-to-date description and discussion of tunneling methods. As a text-book for the student it has many claims to merit, but for the practicing engineer in search of facts and suggestions which he can apply in his work it fails to meet all requirements. In all fairness to the book, however, it must be

said that it meets the general demand for an up-to-date discussion of modern tunneling work more nearly than any book in the English language at present available to engineers. There are a considerable number of books on tunneling in German and French, and at least one excellent treatise in Italian. In the preface to his monumental work Drinker gives a brief critical estimate of these various books, with a weight of authority which makes it unnecessary to mention them further here. We should, however, by all means add to the list the recent work by Reynold Legouez, on the shield system of tunneling, entitled "L'Emploi du Bouclier dans la Construction des Souterrains."—Ed.)

Literature on Municipal Charters.

Sir: A commission has been appointed by the Mayor of Trenton to prepare a new municipal charter. As a member of that commission I have been asked to secure all the available information concerning charter reforms in other cities. Knowing your acquaintance with municipal themes, I write to ask you if you can place me in touch with men and literature which will aid us in our work.

Cordially yours, Alfred W. Wishart,
Editor "Times."

Trenton, N. J., Dec. 5, 1902.

(By far the most important contribution to the literature of charter reform is the proposed model charter and accompanying explanatory and critical papers, published in 1900 under the title, "A Municipal Program" ($1). The volume named is the final report of a committee of the National Municipal League. The report was adopted by the League in November, 1899, after several years spent in its formulation and discussion, and has played an important part in the advanced charter legislation of recent years. An editorial review of this report, as submitted for general discussion before its final adoption, appeared in Engineering News of Dec. 1, 1898. The bulk of the matter in "A Municipal Program" was published in the proceedings of the National Municipal League for 1900. Both the earlier and later proceedings of this organization contain many papers and discussions on municipal government.

Goodnow's "Municipal Home Rule" and "Municipal Problems" ($1.50 each), Wilcox's "The Study of City Government" ($1.50), Shaw's "Municipal Government in Great Britain," and his similar work on Continental Europe ($2 each) severally contain much information bearing directly and indirectly on the contents and practical operation of city charters. More recent than any of the foregoing books is Fairlie's "Municipal Administration" ($3), which contains a section on "Municipal Organization," with chapters on the city council, administrative officials, the mayor, and "Proposed Plans of Municipal Organization." In Baker's "Municipal Engineering and Sanitation" ($1.25) there are chapters on "City Charters" and "The Departments of Public Works and Engineering," respectively.

Turning from general and theoretical discussions of the city charters to the documents themselves, we would recommend for study the charters of Baltimore and San Francisco, and the new Municipal Code, just enacted by a special session of the Ohio Legislature. It might prove instructive to compare this code with the one proposed in 1899, by the Ohio Municipal Code Commission. Probably the two documents could be obtained from the Secretary of State, at Columbus, O.

Abstracts of and nofes on the charters or corporation laws of New York, Indianapolis, Milwaukee, St. Louis, New Orleans, San Francisco, Seattle, Zurich, Vienna, Calcutta, Shanghai, Sidney, Germany, New Zealand, and Canada, are given in a paper of 130 pages, published in the Proceedings of the American Society of Municipal Improvements for 1900 ($1). In the "Journal of the Association of Engineering Societies" for March, 1892, there appeared a number of papers on "Municipal Government, with Especial Reference to the Management of Public Works," in Boston, Providence, New York, Philadelphia, Buffalo, St. Louis and Paris. These papers were abstracted in Engineering News of Jan. 23, Feb. 27, and March 5, 1892.—Ed.)

The Story of the Erie Railroad.

BETWEEN THE OCEAN AND THE LAKES.—The Story of Erie. By Edward Harold Mott. New York: John S. Collins. Cloth; 9 x 12 ins.; pp. 524; illustrated. $7.

In this day of vast industrial and commercial enterprises the birth of a railway, even of transcontinental dimensions, excites little more than passing comment. Such a line would be planned, financed and carried to completion from some Wall Street office, and the public generally would only be interested in the added transportation facilities thus afforded. Conditions were very different seventy-odd years ago, when sanguine men first began to discuss the possibilities of the railway, whose story Mr. Mott here tells so exhaustively and in such an interesting manner. At that date there were less than sixty miles of so-called railway within the limits of the United States, and these were built for carrying stone or coal, rather than passengers. The methods of construction and operation were still new, almost untried; and an engineer of some reputation in his day gravely devoted a volume to arguing that for reliable speed and operating economy oxen were far superior to the English locomotive proposed for a Massachusetts railway.

The advantages of the railway over the then popular canals were first laid before the public in a pamphlet published in 1829 by William C. Redfield, of New York. Mr. Redfield entitled his pamphlet, "A Sketch of the Geographical Route of a Great Railway, by which it is proposed to connect the canals and navigable waters of New York, Pensylvania, Ohio, Indiana, Illinois, Michigan, Missouri and the adjacent States and Territories, opening thereby a free communication between the Atlantic States and the great valleys of the Mississippi." With prophetic accuracy the author of this pamphlet, starting on the Hudson at New York, lays down a route to Rock Island Rapids, on the Mississippi, that is now the main artery of railway traffic for the country. In leaving the Hudson he followed what is now practically the line of the Erie Railway; and his utterances excited sufficient public attention to induce the national government, in 1831, to have a reconnoissance made by Col. De Witt Clinton, of the Engineer Corps, U. S. A., of the route proposed by Mr. Redfield.

Antedating Mr. Redfield's more ambitious project, the Mohawk & Hudson Railway, had been chartered in 1826, and was completed in 1831; and this road is remarkable in the transportation history of our country as being the first one built for passenger traffic. A railway epidemic resulted, and everywhere public meetings were demanding railways; even proposing to parallel the recently completed Erie Canal, from Albany to Buffalo. One of these meetings was held at Monticello, Sullivan Co., N. Y., on July 31, 1831; and its outcome was an application to the New York Legislature for permission to incorporate a company, with $10,000,000 capital, to build a railway from New York to Lake Erie. Such a charter was actually granted on April 24, 1832; but the conditions imposed made it practically impossible to obtain subscriptions, or even enough money to pay for the surveys. In this emergency application was made to the national government, and in 1832 the War Department directed that a survey be made on the Erie route, at the federal expense. But President Jackson ordered the discontinuance of this survey upon the ground that there was no constitutional warrant for such expenditures. In 1833, the friends of the Erie scheme succeeded in having its charter so amended that a subscription of $1,000,000 would enable them to organize the company; on this basis the necessary subscriptions were soon secured. Eleazar Lord was the first President, and under his energetic control the material history of the road began with the appointment of Benjamin Wright as Chief Engineer, with James Seymour and Charles Eliet, Jr., as his assistants.

In 1835, the surveys were completed from New York to Lake Erie; on Nov. 7, 1835, ground was broken for construction, east of the Delaware River, near Deposit, N. Y. In 1838, H. C. Seymour, then Chief Engineer, was led by the experience of English engineers to advoate the adoption of a 6-ft. gage for the new railway; this unfortunate recommendation, and its subsequent approval by the directors, cost the Erie treasury about $25,000,000 in original equipment and operation, and in the later necessary change to standard gage. On Jan. 7, 1848, the road was officially opened to Port Jervis; and on May 14, 1851, President Fillmore and members of his cabinet declared the Erie Railway open for traffic between New York and Lake Erie.

When the last spike had been driven the Erie road had cost its promoters about $23,500,000, or six times the original estimate of Chief Engineer Wright, in 1834. The history of the Erie Railway, from the beginning, shows a succession of financial trials, struggles for business, rate wars, and attempts of rival factions to control its affairs. One of its first and most powerful antagonists was Connelius Vanderbilt, who seriously depressed Erie interests in his development of the New York Central system of railways. The names of Jay Gould and James Fisk, Jr., enter as factors into the affairs of the Erie in 1868; and the litigation, arrests, and charges of corrupting the Legislature that are coupled with these names form "the shady chapter" in the history of Erie Railway exhaustively related by Mr. Mott. In 1868 Jay Gould became the President, and then the Receiver, of this road. He at once began to extend its area of influence by leasing the Atlantic & Great Western Railway from its chief English owner, Mr. James McHenry, thus giving him a continuous line from New York to Cincinnati and St. Louis. He next attempted to absorb the Pittsburg, Fort Wayne & Chicago Railway by securing the majority of its stock, but he failed in this, through the opposition of the Pennsylvania Railroad Co., which finally added the road to its system. These attempts cost the Erie enormous sums of money, and the lack of dividends aroused the active enmity of the English holders of Erie stock. On March 15, 1872, Gould was compelled to resign, leaving the company practically bankrupt. Jay Gould was so unpopular with all interested in Erie affairs that the news of his resignation sent the stock up about twenty points in the market; and Gould, shrewdly foreseeing this, is reported to have made several millions for his personal account on this rise.

The financial troubles of 1874 resulted in the appointment, in May, 1875, of a former President, Hugh J. Jewett, as Receiver, and his wise control lasted until 1884. In this period the gage was changed to the standard, the road was laid with steel rails and double-tracked throughout, terminal facilities were enlarged, the rolling stock was improved, and a profitable lease was made with the Atlantic & Great Western Railroad Co. In 1893 the company was again reorganized, and while generally prosperous, it is still struggling under the burden of a $300,000,000 debt.

Mr. Mott, in his "Story," recalls many engineers forgotten by the present generation, and tells interesting experiences of the early building of the Erie. One of these relates to the unfortunate experiment of substituting a "pile roadway" for the standard railway embankment. This experiment was tried upon the recommendation of Gen. Charles B. Stuart, who thus built the Syracuse & Utica Railway in 1839; and General Stuart contended that his plan was more economical in construction, not liable to derangement by frost, obstruction by snow, or damage from freshets. A section of the railway was actually built upon white oak piles, with caps, stringers and crossties; but it is hardly necessary to say that experience condemned General Stuart's innovation. The fact that, in 1843, the Erie operated two "sleeping-cars," built by John Stevenson, of New York, so nonplussed the lawyers in the Pullman-Wagner litigation of 1879, that its discovery brought about a suspension of the legal controversy, and a compromise between the principals—for the common good. To the Erie management also belongs the credit of first practically applying the telegraph to operating a railway. This was done in the autumn of 1851, by Charles Minot. But for the many other interesting and historically valuable details of this story of the up-building of a railway the reader must be referred to the book itself, which, as a record of the times and men involved, stands unrivalled.

Two Books on Aerial Navigation.

LES DIRIGEABLES (Dirigible Balloons).—By M. H. André, Member of the French Society of Civil Engineers. Paris: Ch. Beranger. Cloth; 8vo.; pp. 346; illustrated. $3.75.

In his preface the author naïvely remarks that the problem of aerial navigation is "not yet entirely solved," but while he is evidently somewhat of an enthusiast in the matter, his book is practical and interesting. It is mainly a review of what has actually been done, and refers exclusively to dirigible balloons, the flying machine not being considered. After a brief historical introduction, the theory of the balloon is discussed mathematically in regard to pressures. This is followed by a chapter on the construction of an air-ship, showing the valves, the basket or carriage, and the anchors, and by another interesting chapter on the inflation and floating of the balloon. The conditions governing the problem of dirigibility are then discussed, together with the resistances to be overcome, a number of formulas and diagrams being given. Two long chapters are devoted to propulsion and stability, and a disappointingly short chapter discusses light motors adaptable for air-ships. This part of the book, which deals with the subject in general, covers about 180 pages.

The next part deals with actual experiments, and is arranged chronologically. It begins with the work of General Meusnier, 1783, and includes that of some 20 other experimenters, concluding with Zeppelin, Santos-Dumont, Severs and De Bradsky, up to the present year. The two last have only recently lost their lives in this work. Many of the machines and voyages are described in considerable detail, and there are a number of views and diagrams. Mr. André modestly concludes with a short description of an air-ship of his own design, but he closes his book with this sentence: "Why should we not dispute the occupation of space with the powerful eagle and the swift swallow." The book appears to be an excellent and compact treatise upon a problem which is of increasing interest, but which is very much farther from practical solution than the author would seem to believe.

AERIAL NAVIGATION.—A Practical Handbook of Dirigible Balloons, Aerostats, Aeroplanes and Aeromotors. By Frederick Walker, C. E. New York; D. Van Nostrand Co. Cloth; 5 × 7¾ ins.; pp. 151; illustrated. $3.

"Since recent successful experiments and commercial enterprise have combined to render aerial navigation a prominent feature in progressive science," says the author of the book, no apology is needed for its publication. In the main we agree with him, particularly since the book is a good one in most respects and will doubtless serve well enough its purpose, which is, to quote again, to treat of

> the laws governing flight as exemplified by animals, birds and insects, and of the construction of dirigible balloons, aerostats, aeroplanes and aeromotors to be synthetically deduced therefrom and illustrated by various types already made.

The author has evident belief in a successful future for aerial navigation, if we may judge from the following statement:

> No human mind can foresee the airship of the future, except that aerial navigation will be a matter of everyday usage and will give rise to a new industry throughout the world.

In view of this very confident prophecy we are somewhat at loss to understand the following statements from the preface:

> From a commercial point of view the advantage to be derived from any increased speed due to aerial navigation as against other modes of locomotion are not immediately apparent except for light postal services.
>
> Aerial navigation can only effect a revolution in international matters by the discovery and application of the neutralization and regulation of the force of gravity.

If we are to await some means of neutralizing the force of gravity it is clear enough that "no human mind can foresee the air ship of the future," but the probability of the remainder of the prophecy is not so obvious. The author does better when he abandons the role of prophet and devotes his attention to the technical side of his subject.

In the opening chapter the laws of natural flight are discussed briefly, taking as examples the flight of certain birds and of bats and insects. The succeeding chapter is entitled "Aerostatics," and in it are discussed briefly the properties and density of the atmosphere, the principles of aerial flotation, and allied questions. Under the chapter heading "Aerostats" the author next describes the various improvements of recent years in the design and construction of aerostats, or, more familiarly, balloons. The machines of Serkis-bey, Gower, Bati, Dale, Fryers, Glendenning and others are here briefly described and illustrated. Most of these machines have been designed for special purposes, such as military operations, life-saving work at sea, cable tramway support, and similar purposes essentially apart from aerial navigation as a means of locomotion. The next chapter, on "Aerodynamics," is devoted chiefly to an explanation of Prof. J. Bell Pettigrew's theory of wing movements, and to a description of various artificial or mechanical wing devices, which have been constructed and experimented with by Pettigrew, Smythie, Cornelius, Quartermain, Capone and others. The problems of screw propulsion, paddles and aeroplanes is dealt with in Chapter V., which gives much interesting information, particularly as respects the construction of propellers and aeroplanes designed and built by different experimenters. As might be anticipated, the work of Sir Hiram Maxim occupies a prominent place in this exposition. Chapter VI. takes up various questions of motive power for flying machines. Maxim's generators and the various forms of internal combustion engines for air ships are described and illustrated; electric motors are also briefly considered. In Chapter VII., the structure of air ships is briefly discussed, some of the more important topics being models, framework, castings, bearings, shafting, wire stays, wood and aeroplanes. The next chapter, on "Air Ships," is chiefly historical and descriptive, and with the descriptive portions of the preceding chapters gives a fairly complete history of the development of flying machines and air ships. The book closes with an appendix, giving tables and other useful data and with illustrations and a short description of the Santos-Dumont air ship.

An Encyclopedic Dictionary for Architects and Engineers.

A DICTIONARY OF ARCHITECTURE AND BUILDING. —Biographical, Historical, and Descriptive. By Russell Sturgis, A. M., Ph. D., and Many Architects, Painters, Engineers and Other Expert Writers, American and Foreign. In three volumes. New York: The Macmillan Co. Cloth; 8 × 11 ins.; pp. 471, 530, 606; many full-page plates and illustrations in the text. $18, net.

The comprehensive character of this work, its apt and often beautiful illustrations, the freshness and originality of many of the articles, and the high professional standing of the editor and a number of his associates, all combine to make this encyclopedic dictionary a model of its kind. The need for such a work has long been felt, and has been growing more pressing as architecture and building have developed from comparatively simple arts, chiefly notable for their esthetic and constructional features, to a grand series of co-operative sciences.

The first article of note on engineering and allied topics is the one on "Aqueducts." After defining an aqueduct broadly as "a pipe or channel of any form, but usually covered and protected from injury," Mr. Sturgis proceeds to discuss the subject in the narrow sense to which the word is usually restricted; that it, as a closed conduit, generally not under pressure. No cross-references to pipe lines or other forms of conduits are given.

The entries under "Arch" may serve to illustrate the treatment given to the most important topics. There is a general discussion of arches, followed by some 70 sub-definitions, and accompanied by numerous sketches of different kinds of arches.

Under "Baths" (by W. P. Gerhard) there is an illustration (ground plan) of a bath at Frankfort-on-Main, but no illustrations of any of the recent American public baths.

The article on "Bridges," by Mr. Sturgis, contains very little about bridges as engineering structures and has no bibliography.

"Chimney" is an unsigned article, and is one of the comparatively few instances of apparent failure to assign important articles to some one who has some claim for recognition as an authority. Steel chimneys are not mentioned in this article.

"Concrete" by the late Wm. R. Hutton, gives no hint of the present widespread and rapidly increasing use of that material, and has no bibliography. Mixing by machinery is said to be preferable to hand mixing, but nothing is given on such machinery.

"Contracts," by Mr. Sturgis, also lacks a bibliography. "Corrosion" is an unsigned article of seven lines, with no mention of means of prevention, and no cross-references. "Cremator," by Mr. Sturgis, refers briefly to furnaces for dissecting rooms and also for the disposal of the dead, and speaks of "small furnaces" connected with the kitchens or sculleries of dwelling houses, but there is no mention of garbage crematories.

"Day's Work," another unsigned article, fails to give any information on the number of hours comprising a day in this or foreign countries. "Electrical Appliances," by Mr. Russell Robb, includes 47 different devices and occupies 6½ pages, besides a half page given to electric elevators. "Elevators," also by Mr. Robb, is inadequate, even when taken in conjunction with the articles on electric elevators and office buildings.

The article on "Engineering," by Mr. Sturgis, deserves praise, particularly for its comparison of architecture and engineering, and its sensible words about the need of coöperation between engineers and architects. "Expansion," by Mr. Hutton, is one of the few articles containing comparative figures, or rather data, for different materials, and also one of the few including even brief mathematical discussions. "Filter," by Mr. Gerhard, conveys no idea of the slow sand filtration process, although it mentions it. "Fireproofing," by Mr. C. T. Purdy, is a comparatively full discussion of the subject, clearly put. About the same may be said of Mr. Hutton's article on "Iron Construction" and also of his article on "Steel."

The deficiencies in the article "Chimney," mentioned above, seems all the more pronounced when one finds that two of the four reference books under "Masonry" are on chimneys, while that subject was not given a bibliography of its own. Mr. Cleveland Abbe's article on "Observatories" seems to be particularly good.

"Preliminary Studies," "Refinement in Design," "Round Church," and "Study of Architecture" seem to show a faulty idea of classification or indexing, but are hardly as bad in that respect as "Farther India."

There are articles on "Slow Burning Construction," by Mr. Edward Atkinson; "Stone," by Mr. Geo. P. Merrill; "Surveying," by Mr. Danford N. B. Sturgis; "Ventilation," by Mr. Wm. J. Baldwin, and "Warming," by Mr. Sturgis. The latter, like so many other of the articles by the editor-in-chief, has no bibliography. Mr. Gerhard and Mr. Hutton have a number of articles, besides those mentioned, on general and sanitary engineering, respectively.

From the foregoing citations it appears that many, at least, of the engineering articles, are treated quite lightly, but it is doubtful if any other work primarily for architects contains anything like as much good engineering matter, while on things architectural the engineer will find a wealth of information, much of which may be of direct and most of indirect service.

One of the most impressive features of the strictly architectural sections of the work is the large number of articles, many of them extensive, elaborate, and well illustrated, on the architecture of the different countries of the world. The article on the United States occupies some ten pages, and was written by Montgomery Schuyler. Its illustrations are mostly of colonial architecture.

The architect in England, France, and Italy is treated, each by a different writer, following immediately after a discussion of the architect in general, by Mr. Russell Sturgis. The latter defines the term architect as follows:

> A man charged with the preparation for a building, its plan and design, and with the supervision of the work of the builders who actually put it up and finish it. . . . The term signifies nothing more than head workman, or director of the workmen, and the exact duties of the architect vary with the epoch, the country, the kind of building, and the wishes of the owner.

Further on the author says that: "the modern architect is equally in his right place and doing

his work as architect when the building in hand is wholly without artistic character as when it is rich and beautiful."

Having found what an architect is, an engineer naturally turns over the pages to see what is said of himself or his profession. He finds more than a page devoted to "Engineering," also by Mr. Sturgis, and very interesting reading it is, as the following extracts will show:

> The study and pursuit of mechanical or constructional occupations, according to theoretical and strictly scientific principles, as distinguished from similar work done by traditional or empirical methods. . . . An architect may be actively employed for a number of years without ever having had occasion to use engineering methods himself or to consult a professional engineer. . . . In a general way the division between the architect's and the engineer's work may be expressed in this way: Whatever is traditional in form and in structure, whatever is admittedly safe, whatever is known to all practical builders as well within the limits of danger, comes within the architects' province; and nearly all his most important artistical results are procured from the treatment of such building as this. All that is so new or so complex as to require careful scientific examination based upon mathematics is the province of the engineer. Some, but not many, modern architects are themselves competent, and, up to a certain point, may trust their own computations. Some, but not many engineers, have something of that traditional respect for beauty and significance of form that they make their own designs for the decorative effect of structures which they have to carry out. The great majority of either profession, are men who are greatly in need of those of the other profession, and what the outcome will be is at present entirely uncertain.

Whatever one may think of some of these statements, certainly the last sentence is sound doctrine. And we may add, in conclusion, that the "Dictionary of Architecture and Building" will doubtless contribute largely to the much-needed but already increasing coöperation between the professions of architecture and engineering, and thus help to resolve the uncertainty regarding the final outcome of the relations of two of the most important professions of the age.

A Treatise on Mechanical Refrigeration and Its Applications.

REFRIGERATION, COLD STORAGE AND ICE-MAKING. —By A. J. Wallis-Taylor, Assoc. M. Inst. C. E. London: Crosby, Lockwood & Son. New York: D. Van Nostrand Co. Cloth; 6 × 9 ins.; pp. 590; 361 illustrations. $4.50.

The production of cold by artificial means is an ancient art, but it is only in comparatively recent times that improved systems and apparatus have made it possible to conduct such operations on a commercial scale. The vast progress recorded by the compact and efficient refrigerating apparatus of to-day over the crude practice of the ancients cannot, however, be credited to any one individual or to any single epoch-making invention. It has, on the contrary, been a slow growth, to which many inventors have contributed, and due consideration to those many workers is necessary to anything like a thorough understanding of artificial refrigeration as it is practiced to-day. It is perhaps to the realization of this fact, as much as to its excellent description of modern refrigerating apparatus, that Mr. Wallis-Taylor's book owes its interest to the engineer and takes rank as undoubtedly the best general treatise in English on the subject with which it deals.

The modern applications of artificial refrigeration are already numerous, and its field of usefulness is becoming wider with every year that passes. Ice-making and cold storage now supply the principal demand for refrigerating apparatus and will probably continue to do so for many years. These, however, are not the only industries which require its use. Artificial refrigeration is now an essential part of a number of manufacturing processes, such as brewing, artificial-butter-making, chocolate-making, and sugar refining. It is also employed for bleaching clothes in laundries, for the preservation of furs and fabrics from vermin, for cooling the holds of cattle ships, for reducing the temperatures of dwellings and hospitals, and for various similar purposes of minor mention. In engineering, the freezing process is a well-recognized method of building tunnels and of sinking foundations and shafts in water-bearing soils. This list of applications might be augmented considerably without special search, but it is quite long enough already to show that the writer of a general treatise on refrigeration has a wide field to cover. At best his treatment of some of the various applications of the art must be brief, while others can receive only passing mention or must be neglected altogether. It is too much, therefore, for him to hope that there will not be found those who will criticise his work on one or another of these counts.

In going through Mr. Wallis-Taylor's new book we find opportunities for criticisms of this character, but they are on the whole comparatively few in number. We could wish, for example, that something further than mere mention might have been made of the application of artificial refrigerating processes to the cooling of dwellings in hot weather. In cities, like New York, where people are domiciled in great numbers in large apartment houses, and which, like New York, suffer from a depressingly hot and moist atmosphere in summer, there is a wide opportunity for the use of mechanical refrigeration in cooling the home. In fact, some of the large apartments recently built in New York have been provided with such apparatus designed and arranged on a very expensive plan. It is, however, but fair to say in excuse of their neglect by the author that such applications of mechanical refrigeration are limited in number and have been made very recently and in the case of very luxurious apartments only.

For the purpose of specific review the book which lies before us may be roughly divided into two parts or sections. In the first part the author traces the mechanical development of the different refrigerating processes, and describes the machinery and appliances employed in the most modern and improved practice of refrigeration according to each of these processes. In the second part he describes the manner in which these machines and processes are applied to cold storage, ice-making, marine refrigeration, manufacturing processes and engineering construction. The management and testing of refrigerating machinery, operating costs and like subjects also form a part of this second section.

Considering first the section relating to refrigerating processes and machines, the author begins his discussion with a chapter on the theory and practice of mechanical refrigeration. His treatment of this phase of his subject is very brief and we must confess considerable disappointment with both its manner and quality. To the reader who is familiar with the inter-relations of heat and mechanical energy, and who has his thermodynamics "on tap," many of the explanations given are wholly unnecessary, while for those who do not know these things so well they are set down in so random a fashion as to be confusing. The chapter closes with a classification of refrigerating "processes" which is clear and concise and which we quote as follows:

> The various inventions for refrigerating and ice-making that are now in use, can be conveniently classified for the present purpose under the following five principal heads:
>
> First, those wherein the more or less rapid dissolution or liquefaction of a solid is utilized to abstract heat. This is, strictly speaking, more a chemical process.
>
> Second, those wherein the abstraction of heat is effected by the evaporation of a portion of the liquid to be cooled, the process being assisted by an air-pump. This is known as the vacuum system.
>
> Third, those wherein the abstraction of heat is effected by the evaporation of a separate refrigerating agent of a more or less volatile nature, which agent is subsequently restored to its original physical condition by mechanical compression and cooling. This is called the compression system.
>
> Fourth, those wherein the abstraction of heat is effected by the evaporation of a separate refrigerating agent of more or less volatile nature under the direct action of heat, which agent again enters into solution with a liquid. This is termed the absorption system.
>
> Fifth, those wherein air or other gas is first compressed, then cooled, and afterwards permitted to expand whilst doing work, or practically by first applying heat, so as to ultimately produce cold. These are usually designated as cold-air machines.

The liquefaction and vacuum processes of refrigeration are of scarcely more than academic interest at the present time. It is true, of course, that both liquefaction and vacuum apparatus are still used, but they are represented by the familiar ice-cream freezer in one case and by small hand-operated devices for domestic ice-making in the other case. The author's treatment of these two processes is, therefore, of necessity largely historical and descriptive in character, and in the two chapters devoted to their discussion he has given them about all the space that their importance warrants.

To the compression process the author gives four chapters of his book, or about 120 pages, which is certainly not overmuch space considering the important part played by it in modern refrigerating practice. The general principles of the process and its historical development as represented by the successive discoveries and inventions of Cullen, Perkins, Twining, Harrison, Tellier, Pictet, Windhausen and other early investigators are described first. A chapter of 58 pages is then devoted to the consideration of ammonia machines. In this chapter the author discusses in order the properties of ammonia, the cycle of operations of ammonia compression apparatus, the wet and dry compression principle and other general questions, and then describes very fully the most important types of modern ammonia machines. American machines as well as those of England and the Continent receive full consideration in this chapter, and, it may be said now, in all other parts of the book as well. This fact is worthy of special note, since it is too often the practice of English writers of text-books to neglect to consider the work of American engineers, while at the same time appealing to their patronage. Ether and sulphuric and carbonic acid compression machines are given a separate chapter, the manner of treatment following closely that adopted in considering ammonia machines. A final chapter, which properly belongs to the author's consideration of the compression process, discusses and describes condensers and water-cooling and saving apparatus.

The absorption process and the cold-air system are given a chapter of about 30 pages each. The method of treatment is substantially the same for both processes; the general principles of the process are first enumeriated, its historical development as represented by succeeding inventions is then traced, and, finally, the various principal types of modern machines are described and discussed. Regarding the absorption process the author says that the first machines were very imperfect in operation, but in later inventions the distillate has been rendered nearly anhydrous and absorption machines have been brought to a very considerable degree of efficiency. Of cold-air machines he remarks that several notable recent improvements have put them quite to the forefront for the refrigeration of food-stuffs.

Turning now to the author's consideration of the application of refrigerating processes to various purposes, we find first 115 pages treating of cold storage. The various systems for refrigerating cold stores are first described and the construction of cold stores, including arrangement, ventilation, piping, insulation, air circulation, etc., is then discussed in detail. Two chapters are devoted to hoisting and conveying machinery for cold stores, and to the discussion of methods and presentation of data relating to the proper way in which to store various articles, as meats, fish, eggs, butter, cheese, fruits and vegetables, and to the proper temperatures required for their preservation. Much tabular information respecting insulating materials, temperatures, etc., is given in these chapters.

Marine refrigeration is given a special chapter, in which are discussed first the various types of refigerating machines used, and second the arrangement of cargo, holds and stores. Ice-making machinery for ships is also described. Two chapters follow, in which the author discusses and describes the manufacturing and constructional applications of mechanical refrigeration. In regard to the manufacturing applications, it is sufficient perhaps to say that the author gives separate consideration to some 15 manufacturing processes in which refrigeration has come to be an essential part and mentions more or less briefly a number of others. To civil and mining engineers the sections on shaft sinking and tunneling by the freezing process will, however, be the most interesting portions of this chapter and perhaps of the whole book. About ten pages are devoted to these subjects. A chapter of 40 pages covers all the author has to give on ice-making, but a large amount of general and detailed information has been condensed into this space. In the two succeeding chapters the management and testing of refrigerating machinery are discussed in detail and figures of the cost of operating refrigerating and ice-making machinery are given. The concluding chapter of the book treats, in a historical and descriptive manner, of the production of very low temperatures.

Altogether the book which Mr. Wallis-Taylor

has prepared is one of unusual interest and value, and can be read with appreciation not only by those skilled in the design and construction of refrigerating machinery, cold stores and ice-making plants, but by engineers in general. The text is copiously illustrated and the illustrations are for the most part excellently chosen to supplement and explain the text.

Municipal Activities, Finances, and Organization; Ancient, Medieval and Modern.

MUNICIPAL ADMINISTRATION.—By John A. Fairlie, Ph.D., Assistant Professor of Administrative Law, University of Michigan. New York: The Macmillan Co. Cloth; 6 x 9 ins.; pp. 448; $3.

The author of this book showed no little courage in attempting to review, in a single octavo volume of moderate size, the history, activities, finances and organization of ancient, medieval and modern cities. We shall not attempt to criticise *in extenso* a book made up of such a mass of details, but after speaking generally of the treatise as a whole, we will content ourselves with some comments on the two chapters devoted to municipal improvements. Our impression, then, is that this is an unusually good and comprehensive study of the whole range of municipal affairs, mostly from the academic view-point. The trend of municipal administration through the centuries, and its present general status, are clearly shown, and many particulars, both of other and present days, are given.

The sections of the book which we have examined with most care, that is, the two chapters on "Municipal Improvements," indicate that here, at least, the author has been too dependent on his books of reference, so that, lacking a personal knowledge of most of the subjects discussed, and having but little recourse to current literature, occasional errors of fact and of judgment appear. Thus we are told under the final disposal of sewage that "mechanical filtration is used at Altoona, Pawtucket and Taunton," and intermittent filtration at Lawrence and South Framingham, whereas both Altoona and Pawtucket employ intermittent filtration, and Taunton has not yet adopted sewage purification works. In fact, mechanical filtration is a term rarely applied to sewage treatment, although common enough in water purification. Worcester, Mass., "and a few smaller places" are cited as examples of chemical precipitation of sewage, but the city of Providence, R. I., is now the largest city employing this method. No hint is given of the so-called bacterial methods of sewage treatment which have received so much attention during the past ten years in England, and during the past five years in the United States.

Under the head of "Scavenging" there is no intimation that many American cities have built garbage crematories, and the nearest approach to a mention of the numerous huge garbage reduction plants for the recovery of grease and fertilizing material is that "a small proportion" of the garbage and street refuse of New York "is utilized at works on Barren Island."

Coming to the purification of water, Lowell, Mass., and Providence, R. I., are cited as having two of the five "principal sand filtration works," when in fact Lowell never had such, and Providence let the contract for filter beds only a few weeks ago. Furthermore, New Orleans is spoken of as the largest city having "means of mechanical filtration," and it is added that Albany and "Elmira may also be mentioned." New Orleans has not yet enjoyed the benefits of water purification of any kind, and Albany is notable for its slow sand filtration plant, instead of mechanical filtration works.

Another slip is the statement that "the use of iron and steel for piping has been an important factor in extending" water-works distribution systems, whereas of course the author should have noted, instead, the use of steel pipe in his previous discussion of the aqueducts pertaining to supply systems.

The foregoing should by no means be taken as an indication that the book abounds in such misstatements throughout, for while we cannot vouch for its accuracy in all other portions, a minute examination of some of the other sections led to no results save a feeling of satisfaction that a single writer should have summarized the leading facts in so broad a field in so admirable a manner.

Sanitary Legislation and Practice, Chiefly With Reference to Boards of Health.

MUNICIPAL SANITATION IN THE UNITED STATES.—By Charles V. Chapin, M. D., Superintendent of Health of the City of Providence. Providence, R. I.: Snow & Farnham. Cloth; 7 x 10 ins.; pp. 970; 113 illustrations in the text; tables and blank forms. $5.

This large and carefully prepared compendium of certain phases of municipal sanitation in this country is one of the most important sanitary books ever published. It is essentially a book of actual conditions and practice, giving in much detail the powers, duties, organization, regulations, and every-day practice of local boards of health. In addition, it gives no little information on sewage and water purification and some other topics of interest to engineers, but naturally enough most of these subjects are treated more exhaustively in other books. As is inevitable in so large a compilation from so many sources some of the information, as the author himself states, was already out of date when the book was sent to press. This, however, is not so serious a matter as one might at first think, since many of the facts presented are valuable for their suggestiveness, quite regardless of whether they are or are not expositions of the practice of to-day. It is only fair to the author, and to readers of this notice, for us to say that the book was published in 1901, but we have made due allowances for this in our criticisms, and the fact that the book still holds its own so well is certainly in its favor.

The volume opens with a review of sanitary organization and legislation throughout the United States. This is naturally followed by a consideration of vital statistics in their many bearings, including the various returns made and how the records in question are kept. Nuisances both general and specific are next taken up, and then plumbing codes and inspection. Up to this point the treatment is largely in the nature of an analysis of state and local legislation, with some particulars regarding the executive work of boards of health. In the chapter on "Water, Ice, and Sewers," both water and sewage purification methods are briefly described, with some references to works in practical operation. These subjects disposed of the various classes of food and their adulteration and contamination are taken up, there being a separate chapter for milk and other dairy products. Communicable diseases require four long chapters, one each on legislation, administration, hospitals, and quarantine. Under disinfection and hospitals there are illustrated descriptions of disinfecting apparatus and hospital buildings, respectively, and in the succeeding chapter, on "Refuse Disposal," there are also illustrated descriptions of garbage cremation and reduction plants and apparatus for the collection of night soil. The last chapter takes up diseases of animals, school hygiene, public baths, gas fitting, laundry inspection, tenements and lodging houses, and other miscellaneous subjects. There are 126 appendices, giving as many record forms, rules and regulations, circulars of instruction, and the like, which alone are well worth the price of the book.

While the book is designed primarily for health officials it contains much which bears directly upon some of the many problems confronting the sanitary engineer, this being particularly true of the chapters on plumbing and refuse disposal. Anyone who has seriously attempted to serve as a member or adviser of a board of health knows the value of having at hand even a few of the health ordinances and regulations in force in other cities, and also how much labor is involved in a thorough comparative study of those few. But here there is available to all a digest of a large part of the most important health legislation and practice of the whole country, elucidated by the comments of an able and experienced health officer who has devoted many years to administrative work and to a comparative study of health board work in its many phases, and who shows none of the sanitary vagaries so commonly found in the writings of health officers.

A few errors have been noted. There are no mechanical filters connected with the public water supply of Nashville, Tenn., and never have been. The sewage of Ilion, N. Y., is not treated by chemical precipitation; Lyons, N. Y., which is credited with practicing broad irrigation, has no sanitary sewerage to make this or any other system of sewage treatment possible. The index is partly made up on the table-of-contents order, and there are occasional injudicious entries like "aluminum boxes for diphtheria cultures." On the whole, however, the index appears to be fairly serviceable, even if not always logical.

In conclusion, one cannot examine this book with care without being impressed with the large amount of painstaking work bestowed upon it by the author, nor without hoping that its value will be recognized and the recognition shown in a practical manner by the health boards and officers and the other sanitarians of the country.

Forestry for Beginners.

PRACTICAL FORESTRY.—For Beginners in Forestry, Agricultural Students, Woodland Owners, and Others Desiring a General Knowledge of the Nature of the Art. By John Gifford, Assistant Professor of Forestry, Cornell University. New York: D. Appleton & Co. Cloth; 5 x 7 ins.; pp. 284; 34 illustrations. $1.20 net.

This readable and suggestive little book tells what forestry is, and its possible relations to farm wood lots, forest estates and landscape gardening; and to the formation and improvement of soil, and the prevention of damage from floods and winds. The geographical distribution of forests is next considered, followed by a section on forming and tending forests. Two chapters on "The Industrial Importance of Forests" deal briefly with the lumber industry, wood pulp, resin and turpentine, maple sugar, tanning materials, the utilization of forest refuse and distillation of wood. Finally a chapter gives a list of the principal federal and state reservations, and another describes briefly the habits, range, and other characteristics of 25 conifers and 25 hardwoods found in American forests. The following quotation from the introductory section will serve not only to convey an idea of what forestry is, as the author conceives it, but also, we trust, to stimulate an interest in the book, and in the important subject to which it is devoted:

Forestry treats of the formation, care, purpose and utilization of forests. It is founded on the natural sciences, the most important of which to the forester is botany. Forestry is primarily an art, or the skilful application of knowledge gained from many years of experience and experimentation. The purpose of a forest may be to check the destructive forces of nature, to yield timber and other products, or to beautify the earth. The term utilization relates to the process of harvesting, converting and disposing of forest products. A forest is something more than a mere clump of trees. It includes not only trees, but other plants and many animals which play parts of more or less importance for good or bad. A forest is a community or society of living things, the most important of which is the tree. The forest is a unit or organized whole consisting of three distinct parts—the canopy, the floor, and the wood mass. The forester speaks of an assemblage of trees as a stand. The stand may be young or old, good or bad, thin or crowded, mixed or pure, regular or irregular. A pure stand consists of one species of trees; a mixed stand, of more than one. In a regular stand the trees are all about the same age and size. In an irregular stand there is no uniformity. The forest canopy and forest floor are interdependent. The forest canopy protects the forest floor, and, in turn, upon the vigor and healthfulness of the canopy depends the nature of the forest floor. Upon the quality of both depends the rate of growth, and upon the rate of growth depend the quality and quantity of wood production. Animals, such as earthworms, loosen and ventilate the soil; bees, in many instances, fertilize the flowers and thus increase the seed crop, and in consequence the number of young trees; toads, bats, birds, and other animals keep in check injurious insects; and countless toadstools, puffballs, and other fungi hasten the decomposition of the leaves and sticks on the forest floor. The forest is a mass of living, struggling organisms. Hundreds of forces are at work for good or bad, to be restricted or favored by the forester for the production of such conditions that the forest may grow to the best advantage for the purpose intended.

Two Books on Electrical Engineering.

THE ELEMENTS OF ELECTRICAL ENGINEERING.—A First Year's Course for Students. By Tyson Sewell, Assistant Lecturer and Demonstrator in Electrical Engineering at the Polytechnic, Regent St., London. Cloth; 6 × 8¼ ins.; pp. 332; illustrated. London: Crosby, Lockwood & Son. New York: D. Van Nostrand Co. $3.

PRACTICAL ELEMENTS OF ELECTRICAL ENGINEERING.—By Chas. P. Steinmetz. Second Edition. Revised and Corrected. Cloth; 6½ × 9½ ins.; pp. 323; 144 illustrations. New York: Electrical World and Engineer. $2.50.

Most persons nowadays early become acquainted with some of the applications of electricity, and therefrom build up some sort of a conception of this mysterious "form of energy." They see wires which "carry" the electricity from place to place and see the filament of an incandescent lamp glow white hot when the current is passed through it; moreover, they know that it is produced in power stations at the expense of coal, and hence realize that electricity is not mysterious enough to enable one by its use to get something for nothing. All this tends toward forming in the mind a substantial working conception of electricity which can be made the basis of subsequent instruction in electrical science without requiring recourse to artificial stimulus or other aid to the imagination.

Not always has instruction in electricity found the ground so ready prepared. Only during the last decade or so has the condition described become at all general. Before then, most of those who took up the study of electricity came to the work with only very hazy, even fanciful, notions on the subject, with a mind more easily disposed to see new and incomprehensible marvels in electrical phenomena than to assimilate them and work with them as definite and important scientific facts. They soon learned, it is true, and left much of their blind wonder behind them; but their attitude to everything electrical was then already determined; and having once approached the subject from the scientific, or the historical side, they could rarely apply their scientific knowledge in a broad practical way.

Now that the condition of those requiring instruction in electrical science (or, as we should perhaps more properly say, electrical engineering) has become materially different from this, it seems natural to expect that the progress of their study of electricity should also be different; that is to say more effective, as well as more economical in effort. Correspondingly, also, the text-books that are presented for the guidance of the student should show a different treatment of the subject, and should recognize the better preparation of the student by assuming a more advanced viewpoint from which to begin consideration of the subject. As a matter of fact, recent text-books on electrical science as a basis of practical or engineering work do meet this expectation, and exhibit a treatment of the subject that indicates an implicit recognition of modern requirements. In this they both speak favorably for the writers of electrical text-books, and promise well for the future of the science by ensuring a suitable instruction and training of the coming generation of electrical engineers.

The difficulties in the way of "teaching electricity" are peculiar. We have a manifestation of something that involves forces and energy interchanges, but which is directly perceptible by the senses in only a few of its phases. Moreover, the something whose existence we recognize is elusive and constantly changing; it appears and disappears in a baffling way. Compare with it the subject of pure mechanics, a branch of science which ultimately is fully as mysterious and difficult of comprehension as that of electricity. But in mechanics we deal with elements which are concrete and tangible; masses, forces, distances, and their derivatives velocities, work, and even acceleration, are all concepts which reach the mind in the most simple ways, and to an appreciation of which the mind is unconsciously prepared from infancy. In electricity the case is radically different. Suppose for a moment that the concept of force were a different one, that force were as intangible as electric pressure; let it be desired to convey a clear idea of the derived concept work, the product of a force and its distance of action: We believe that this would be found a most complex and difficult matter, necessitating, possibly, recourse to the mathematical methods of the treatment of potentials. The teaching of the relations and meanings of the terms of electrical science is fully as difficult and complex as this imaginary example.

The methods popular in the past for "teaching electricity" were fully as peculiar as might be expected from the preceding. It was generally considered proper to initiate the beginner by working him through a miscellaneous course of Leyden jars, influence machines, pith balls, and sealing-wax rods (rubbed with a woolen cloth). After this wholesome mental discipline a great jump was made to primary cells, with special reference to the theory of Grotthus. The learner was then permitted to imbibe, slowly and imperceptibly, the relation known as Ohm's Law. Without disparaging the learner it may be said that if he got to know this law thoroughly he deserved to be classed as an independent scientific investigator. Another method much in vogue was often combined with the preceding. The lodestone was carefully described to the student, and the steel-bar magnet was deduced from this; instructions were given how to magnetize steel needles or pieces of watchspring by carefully stroking them in a certain way over such a magnet, and the student was then in a position to be taught that unlike poles attract, while like poles repel each other. After being left to wonder why a magnetic needle was like a stick of sealingwax, the student was finally shown how a wire connected with a primary cell could cause a deflection of a compass needle.

Modern methods of text-book instruction in electricity seem better than the old. No uniform method has established itself, however, as is well illustrated by the two books of Mr. Steinmetz and Mr. Sewell.

Mr. Steinmetz's "Elements of Electrical Engineering," now beginning its second edition, has already made its reputation. It is not strictly a text-book, being too compact, and not sufficiently elementary in its manner of treatment, to enable a beginner to work through it with only the usual moderate amount of friction. Aside from this compactness, however, the arrangement of the matter is precisely that of a text-book, beginning with terms that are readily understood, and building up on this by introducing and defining new terms and stating the laws which express their interrelation.

The way in which the subject is introduced is interesting. We begin with the concept of a magnet pole, deduce the field of magnetic force, and express the force relations. "Electric currents (concept supposed familiar) produce magnetic fields also"; the exact relations are formulated. The second chapter introduces electromotive force, states that currents are produced by it in conductors, defines the ratio of e. m. f. to current produced as the resistance of the conductor; in a further chapter the induction of e. m. f.'s is defined. At this point the book passes beyond the usual range of elementary text-books on electricity, and takes up variable and alternating currents. However, the method of the book in getting at the elementary phenomena of electricity is clearly apparent from the preceding part, which covers little over a dozen pages.

The method employed by Mr. Sewell is strikingly different; this is in part explained by his statement that the aim was to treat the subject on non-mathematical lines. Yet this book, like that of Mr. Steinmetz, is "based upon courses of lectures" given to students of electrical engineering. But the object of Mr. Sewell was evidently to make his students familiar with the practical details of some of the commercial applications of electricity; very different from the object of the other book. Mr. Sewell begins by explaining Ohm's law in 13 pages of text. He uses the old and clumsy artifice of the water analogy, and, even more than this, he speaks of a table pushed by a "table-moving force" against the resistance of the rough floor, and by saying that the rate of movement of the table is proportional to the table-moving force divided by the resistance he seeks to make it easier to understand Ohm's law! The analogy of water pumped through a pipe circuit is little better, and the entire chapter seems almost wasted. Still, the idea of beginning with currents, pressures, and Ohm's law is a good one, immeasurably superior to the old way of beginning with the pith balls.

As to the farther development of Mr. Sewell's method, the verdict must be much less favorable. Thirty pages on "Units," wherein the centimeter-gram-second system of electrical units is described, and on "Series and Parallel Circuits," seems a little awkward, being followed by a similar amount of matter on the heating and magnetic effects of electric currents. The arrangement of the following matter seems even more strained; a chapter on the magnetization of iron seems like an introduction to dynamo design; then follows a chapter headed "Electro-chemistry," which describes primary batteries, and another one on accumulators. Then come indicating and measuring instruments and methods, and long chapters on arc lamps and incandescent lamps, which brings the book to p. 258. In these chapters is found, for instance, the process of manufacture of incandescent lamps in detail, and the photometric methods of rating lamps. The remainder of the book, less than 70 pages, treats of the continuous current dynamo and the direct current motor. Nothing whatever is given on alternating currents, to mention one important division of electrical engineering. Without farther comment, it may be said that the choice of kind and arrangement of matter given in Mr. Sewell's book is much better characterized by the subtitle of the book, "A First Year's Course for Students," than by the main title. It should also be stated that the descriptive portions refer almost exclusively to English practice, and therefore the book is not likely to find wide use in America.

As to Mr. Steinmetz's book little more can be said here to give a better idea of the work than is implied by the name of the author and the reputation which the book has gained in its first edition. After defining in a strictly theoretical and mathematical manner the fundamental laws applying to electrical apparatus, space is taken to exhibit clearly the most advanced mathematical methods of treatment of electrical problems, especially the method using the algebra of complex quantities. A second part of the book treats separately the more important types of electrical machinery, and considers these theoretically, but with close reference to the requirements of practice. The author's position with one of the largest electrical manufacturing companies of the world, no less than his reputation as a brilliant mathematical investigator, guarantees the value of these chapters. The abundance of examples, each new subject being illustrated by a problem worked out in detail, makes the book unusually helpful to the student. These examples are quite novel in character, and cover a great range of practical work.

How to Construct Dies and How to Use Them in Power Presses.

DIES, THEIR CONSTRUCTION AND USE.—By Joseph V. Woodworth. New York: Norman W. Henley & Co. Cloth; 5¾ × 9 ins.; pp. 384; 505 illustrations. $3.

After reading but a few pages of this book one becomes aware that the author is writing of his own personal experience, and that in consequence we have a work that is in no sense a rehash of the published experience of others. When the book has been read through, there comes the further conviction that the author has made a splendid addition to the literature of mechanical engineering; and with this conviction comes also the regret that so few men possessed of knowledge gained by years of actual work in or about the shops have written of their experience.

There seems to be an impression among "practical men" that the details of processes with which they are familiar can be of no particular interest to readers. Nothing is farther from the truth. The fact is that by far the greater number of our text-books have been written by men whose viewpoint is from the outside, not from the inside, of the shop. Very frequently writers of of this class give us most excellent treatises upon the elementary principles, but rarely do they possess a knowledge of the little practical kinks and methods that go to make the practical man of value to his employer and to himself.

Therefore to all practical men we commend this

book on "Dies" as showing how much a practical man can add to the world's stock of knowledge. But this is not the sole lesson to be drawn from a reading of this admirable treatise. It is safe to say that there is not a manufacturer of metal work who will not find a hint somewhere in the 384 pages or among the 505 cuts, that will aid him in securing a machine that will reduce his cost of production.

The book treats not only of the details of diemaking for all kinds of press stamped work, from safety pins to metallic coffins, but again and again does the author point out the opportunities for saving in cost of manufacturing articles by means of press work.

In the introductory chapter the author says:

> Let any manager of an establishment which does not number a power press or two among its machine tools stroll through his shop with a power press catalogue in his hand and he will not go far before realizing that he is paying for a lot of unnecessary work in milling, drilling and polishing parts.

In the chapter on dies for shop use, the author has more to say along this line:

> There are throughout the country a number of small shops where duplicate parts of standard shape and size are being constantly made for various special machines and attachments. The adaptation of tools and devices of the kind shown in this chapter—that is using sheet metal blanks instead of castings where practical—would cause some of the people that run such shops to open their eyes and double their production.

In a subsequent chapter the author describes a press for making the tires of wheels used on agricultural machines. With one stroke of the press, 68 tapering holes are punched, into which the spokes are entered and upset. The hub is the only cast part of the wheel. Our readers are well aware of the fact that American clocks and watches owe their excellence and their cheapness to the use of presses for stamping out the gears.

Small boxes that were in former years fastened with nails are now held together more cheaply and better with stamped clips that have projecting teeth which are driven into the wood. Stamped hinges and latches for grape crates to the number of eight million are annually made.

Thus we see that not only is this book an excellent manual for the machinist and the manufacturer, but it is rich in suggestions for the inventor who by application of his genius may make possible the use of a cheap stamped article in place of an expensive cast, or milled one. For example, many small articles, such as egg-beaters, are made with crude cast gear wheels that might be made equally cheap and far better with stamped gear, by rearranging or modifying present designs.

The space that we have given to the general discussion of the advantages of press and die work should not be interpreted as indicating a corresponding space in the book. On the contrary, the book is given over almost entirely to detailed descriptions of dies actually made, most of them by the author himself, and his remarks upon the economy of die work are introduced parenthetically.

In the first chapter the author tells how to construct and use blanking dies, and combined piercing and blanking dies. Then follows a consideration of dies for shearing, burnishing, finishing holes in heavy stock, curling hinges, and metal tubes and a variety of other simple dies for the machine shop. Gong and follow dies, dies for sheet metal parts, bending and forming dies for fixtures, perforating dies for heavy stock, curling, wiring and seaming, and drawing processes for sheet metal shells, are next taken up in detail. A part of one chapter is devoted to coining processes, the balance of this chapter being given up to punches and presses for heavy stock, including beams. The final chapter is entitled "Miscellaneous Dies, Presses, Fixtures, Devices and Special Arrangements for Sheet Metal Working," and among many other specialties it includes dies for punching leather shoe tips, and the cutting of armature segments. Mention has not yet been made of one chapter devoted to feeding sheet metal to dies and on lubrication for presswork, nor of another on annealing tool steel, hardening and tempering press tools, and the proper use of files. Even so detailed an enumeration as the foregoing conveys a very inadequate idea of the range of dies and materials produced thereby that are described and illustrated in this volume. The illustrations include views of complete machines, most of which appear to have been taken from the trade catalogue of a single manufacturer. There are also numerous line drawings of machines, dies, and parts, and of blanks both cut and formed. The index appears to be pretty complete, but not all the entries are properly made; for instance, there are four entries under "set of dies" which might far more properly go with the numerous other alphabetically arranged entries under "dies."

Pathogenic Bacteria and the Soil.

THE EARTH IN RELATION TO THE PRESERVATION AND DESTRUCTION OF CONTAGIA.—Being the Milroy Lectures Delivered at the Royal College of Physicians in 1899. Together with Other Papers on Sanitation. By Prof. George Vivian Poore, M. D. New York: Longmans, Green & Co. Cloth; 5 x 8 ins.; pp. 257; 13 illustrations. $1.75.

The lectures which form about half of this volume and give it a title have been revised somewhat, and as the "other papers" are of more recent origin the book as a whole is fresher than the sub-title indicates. The author is far from being an alarmist on the subject of the earth as an agency in the spread of infectious disease. In fact, he proves himself to be a sturdy champion of agriculture and of maintaining the fertility of the soil by manures, rather than artificial fertilizers. It is not strange, therefore, that we find him averse to water carriage and sewage irrigation as a means of disposal of household wastes, and an earnest advocate of dry earth closets and the direct application of excreta to cultivated land. But in assuming such an attitude, or rather in maintaining an attitude which was evidently assumed long ago, the author appears to have overlooked the fact that even in Great Britain water carriage has gained such a foothold that its complete adoption in all large places cannot long be withstood, while in America and the newer and more progressive countries generally it is practically the only systematic public means provided for the disposal of human excrement. In addition, the author also virtually ignores the vast mass of most interesting and valuable testimony regarding bacteria and sewage farming, bacterial filter beds and the like. The latter, he may perhaps urge, cannot be included under his definition of the word earth, which he says will, in his lectures, "usually be regarded as meaning humus in a healthy condition." Notwithstanding his self-imposed limitations the author has brought together some suggestive facts and theories, particularly those based on his own experience of many years at Andover, England, where, with the aid of a gardener who has shared in the profits, he has obtained handsome returns with no ill effects from the application of the excreta from a hundred people to a little over an acre of highly cultivated land. A shallow well, only some 5½ ft. deep, with a concrete side lining, but open bottom, is situated in the center of this tract. A few scattered analyses of water from the well have shown little or no evidence of contamination, even though manuring is carried on up to within a few feet of the well curb. Other impressive statements are given in the account of the reclamation of large areas of peat bog with excreta and other organic refuse from and by the city of Manchester.

Besides typhoid fever, the author treats of tetanus, anthrax, malaria, diarrhœa, dysentery, diphtheria and some less common diseases, in their relation to the soil. In general, it may be said that the author does not believe man is in much danger of soil-infection from any form of these diseases, provided he takes reasonable precautions against the accumulation of filth, and, as regards tetanus and anthrax, does not allow the soil to come in contact with flesh wounds. In conclusion, mention may be made of a paper on "Milk in Its Relation to Health and Disease," and also to the illustrated description of a one-story cottage, with an earth closet, a combined gutter, or perforated open drain, and filter for slops, and a large cistern, with filter, for maintaining a supply of water collected from rainfall on the roof.

Parallel Tables of Logarithms and Squares of Feet, Inches and Fractions of Inches.

SMOLEY'S TABLES.—Containing parallel tables of Logarithms and Squares of Feet, Inches and Fractions of an Inch. By Constantine Smoley, C. E. Flexible Leather; 5 x 7¼ ins.; pp. 214. Second Edition. New York: The Engineering News Publishing Co. $3.

The title of the book, as given above, may be further explained by the statement that the logarithms and squares are given for all lengths from 1 to 50 ft., varying by 32nds of an inch. The logarithms are given to five decimal places, and the squares are expressed in feet and decimals. Tables of (1) five-place logarithms of common numbers from 1 to 1,000, (2) decimal equivalents of inches and fractions, expressed as decimals of a foot, and (3) some mathematical constants and their logarithms follow the main tables. Finally, there are given six pages of text containing illustrative examples worked out with the aid of the tables.

The distinctively new feature of the book, as compared with previous tables of squares, is the column giving the logarithms of lengths expressed in feet, inches and 32nds. The range of uses wherein the book will be found helpful is greatly extended by this column. From being of special value only to structural iron draftsmen and a limited class of other workers, by the addition of the logarithms the book becomes of universal applicability in calculating all derived measurements in the geometrical part of designing or laying out. With these tables and a table of trigonometric functions, the tedious computations of skew work, and other cases where lines and angles (especialily when in three dimensions), areas, volumes, etc., require to be calculated, are rendered much shorter and less laborious, and on that account also less liable to error.

The tables of squares are similar to those already provided in Buchanan's and in Hall's tables, but they differ in an important way. Where the older tables are given in steps of 16ths of an inch, Smoley's are given in 32nds; by giving values only up to 50 ft., instead of to 100, the bulk of the book is not increased. In this way the many important problems involving lengths under 50 ft., but expressed closer than 16ths of an inch are taken care of without necessitating recourse to interpolation, while on the other hand, distances between 50 and 100 ft. are covered as accurately as in the older tables if the half lengths be used. A new and excellent method was devised for calculating the squares, and the results were compared with Hall's tables, so that the present book, especially since the second edition was carefully revised and a few typographical errors corrected, is thought to be exact.

As to the mechanical features of the book, it must be regretted that the small and remarkably compact form of Hall's tables could not be adopted, but the addition of the logarithm columns necessarily almost doubled the volume of the matter. The arrangement of the tables is nevertheless an entirely satisfactory one for convenience, there being four pages devoted to each integral foot length, numbered to correspond with the number of feet, by using suffixes a, b, c and d in the page numbering. The size of the book, while exceeding that of the previous tables, is not too great for the pocket. The presswork is clear and the figures are amply large.

Five Hundred Problems for Students of Mechanics.

MECHANICS-PROBLEMS FOR ENGINEERING STUDENTS.—By Frank B. Sanborn, Professor of Civil Engineering in Tufts College. New York: The Engineering News Publishing Co. Cloth; 5½ x 7¾ ins.; pp. 155; 53 figures. $1.50.

As to the contents of this book we can do no better than to quote from the author's preface:

> This book contains many problems similar to those that are found in text-books; but, besides, many have been developed from actual engineering conditions. My object has been to correlate more closely these every-day practical examples with the important subjects in mechanics. As an aid to this end, 15 illustrations (photographic) and 47 line-cuts have been introduced. Although the book is not intended to take the place of text-books or lecture notes, it is hoped that it will in many instances supersede hektograph or cyclostile sheets.
>
> From my own experience as student, engineer in practice, and college instructor, I am convinced that the main object of a course in mechanics should be to prepare students to solve its problems. Therefore, I have endeavored

to make these problems—500 in number—fulfil the requirements for thorough and interesting instruction. They have been arranged in the following order: Work, Force, Motion.

We fully agree with the author that mechanics is best learned by solving problems; indeed it seems to us the only effective way of learning. Rules are soon forgotten, but not so the principles of mechanics once thoroughly learned by solving problems. While this book was written primarily for engineering students in college, it is of value to young engineers in actual practice, for, provided as it is with a good index, there is scarcely a problem in ordinary engineering practice whose like cannot be found among the 500 in the book. As each class of problems is illustrated by one completely solved, as the answer to every one of the 500 is given in an appendix, and as all ordinary mechanical data are given, the book forms not only an excellent text-book, but also a good reference book.

A Reference Library of Modern Engineering.

REFERENCE LIBRARY OF MODERN ENGINEERING PRACTICE. In Ten Volumes. Published by the American School of Correspondence at the Armour Institute of Technology, Chicago, Ill. Each volume 9½ × 7 ins., half-leather binding; total pages about 4,000, with 5,000 illustrations. $40.

The American School of Correspondence, formerly located at Boston, and now connected with the Armour Institute at Chicago, has gathered together its printed instruction papers in the principal departments of mechanical engineering, and offers the set of ten well-bound volumes for sale. The scope of this "Reference Library," as it is termed, may be fairly judged by a statement of the subjects covered by each: In the first two volumes are treated the subjects of mathematics, theoretical mechanics and heat. Vol. III. relates to the foundry, forge and machine shop. Vol. IV., to machine design and boilers. In the next two volumes are treated the subjects of chemistry and metallurgy and engines for stationary, marine and locomotive use. Electricity and its various applications are described in Volumes VII. and VIII.; heating, ventilating and plumbing in Vol. IX., and the concluding volume is devoted to mechanical drawing.

As already stated, the volumes are made up by binding the regular instruction papers used by the school, and the paging is that of these papers and not of the separate volumes. As each volume has an elaborate and well-classified Table of Contents, however, this does not cause the difficulty in looking up matter on a particular subject that might be supposed.

The character of the matter in these books is, of course, governed by the fact that it is intended for the instruction of students whose previous educational opportunities have usually been small. Necessarily the matter is of an elementary sort and presented in an elementary way. Necessarily, also, the information given is confined to the most important parts of the subject under treatment. For example, the paper on Boiler Construction consists of 58 pages printed in fairly large type. Naturally it is out of the question to condense into this space more than a very small fraction of the sum of human knowledge and experience on this subject, or even of that portion of this knowledge which has found record in technical literature. These are the necessary limitations of every work of encyclopædiac proportions, and they are especially marked in this case for the reasons already stated.

Encyclopædias have their field of usefulness, however, and so do elementary treatises, particularly when, as in the present case, the elementary treatise is aiming at practical results and not to instil abstract theory, as is the case with many of the orthodox text-books. An interesting feature at the end of each volume is a set of questions covering the subjects which have been treated and by which the reader or student can test for himself the thoroughness with which he has mastered the contents of the books.

Concerning the mechanical execution of the volumes, we may note that the half-tone engravings and a number of wood-cuts taken from trade catalogues are very poor. The illustrations made especially for the work, however, are creditable. The type is much larger than should be used in a reference work, giving the appearance of padding; but this is due doubtless to the fact that the composition and presswork were chosen with a view to the instruction paper form rather than the present one. The binding is neat and substantial.

The Analysis of Iron and Steel and the Materials Used in Their Production.

THE ANALYSIS OF STEEL-WORKS MATERIALS.—By Harry Brearley and Fred. Ibbotson. London and New York: Longmans, Green & Co. Cloth; 5½ × 8½ ins.; pp. 500; 85 illustrations. $5.

Besides treating of the analysis of iron and steel, this manual gives methods of analyzing the ores of iron, of refractory materials, of slags, of fuel, of boiler water and scale, and of alloys of copper and other metals. There is in addition a 40-page chapter on the microscopic analysis of steel. In an appendix to the volume there is a complete bibliography of all articles relating to the analysis of iron and other metals that have appeared in the "Chemical News" since 1860, the "Journal of the Iron and Steel Institute" since 1880, the "Journal of the Society of Chemical Industry" since 1882, and the "Journal of the Chemical Society" since 1885. The bibliography of these four English journals covers 130 pages of the manual, giving an excellent idea of the scope of the book itself, and the large amount of work required for its compilation.

From the use of the word "compiling" it should not be presumed that the work is a mere compilation; for no method has been described that has not been personally tested and verified by the authors, the practice of each method extending over considerable time.

The book has evidently not been written primarily to serve as a text book for college students, but as a manual for chemists in practice, and as such it cannot fail to find a very large field of usefulness.

A Systematic Attempt to Teach Metallurgy by the Laboratory Analytical Method.

METALLURGICAL LABORATORY NOTES.—By Henry M. Howe, Professor of Metallurgy in Columbia University. Boston, Mass.: The Boston Testing Laboratories. Cloth; 6 × 9 ins.; pp. 140; 44 illustrations; 10 tables. $2.50.

As stated in his preface, the author presents in this book the first systematic attempt to teach metallurgy by the laboratory analytical method. It has been the custom in the past to teach students by what may be called the applied method, the method of actual practice. The author believes this old method to be a poor one and we concur in that opinion. The foremost teachers of applied science are agreed that the laboratory method of teaching is the only method deserving serious consideration; but they differ as to what shall be taught in the laboratory. Shall an attempt be made to reproduce in the laboratory the methods and means used in actual production; or shall the attempt be made rather to teach the principles underlying the methods by numerous and comparatively simple laboratory experiments? Professor Howe believes in the latter method, and he is by no means alone in his belief.

To begin with, it is practically impossible to teach metallurgical students all the details of manipulation of all the commonly used processes of reduction and refining; and even when an attempt is made to teach the details of some few selected processes the time of the student is so taken up that he has none left in which to master the principles of other important metallurgical processes. Furthermore, great attention to such details on the part of a student tends to obscure the underlying principles.

The book is admirably clear and after performing the ninety-one experiments described in it a student should at least have acquired a good insight into the various metallurgical methods of treating iron and steel, copper, gold and silver.

The author expresses regret at not being able at this time to include other metals, and it is sincerely to be hoped that in the next edition he, and others as well, may have no such cause for regret.

On page 97, experiment 76 consists in calculating the charge and the point at which roasting the pyrites should cease to give the greatest profit. Such problems take but little of the student's time and are exceedingly valuable, since they impress upon him the fact that he is learning the science of dollars and cents. It would therefore be well were many more such problems inserted in the book. Experiment 88 brings out the principle of the cyanide process. In view of the already great importance of this process, and its growing popularity, it would be well were there not one, but several experiments under that head. For example, the economic applicability of the process depends not only upon the state of the gold in its ores, but upon the quantity and character of certain minerals associated with the gold. Experiments should be made to teach the importance of these conditions by enabling the student to note the varying quantities of cyanide consumed. The market price of the cyanide should be given, or better still the student should be required to look it up; and, as in experiment 76, he should be required to calculate the cost of winning the gold from the ores. We cannot too strongly emphasize this matter of costs, for it is easily taught, and it brings the student to see that he is studying an eminently practical subject in an eminently practical way.

How to Test Gas Coals and Oils, Illuminating Gas, and Its By-Products.

GAS ANALYSTS' MANUAL. Including Hartley's "Gas Analysts' Manual" and "Gas Measurement."—By Jacques Abady, M. Inst. Mech. E. London and New York: Spon & Chamberlin. Half leather; 5½ × 8½ ins.; pp. 676; 102 illustrations; 70 tables. $6.50.

This manual is doubtless the most complete treatise in the English language on testing illuminating gas. The chapters on "Photometry," "The Table Photometer and Photometer Room," and "Standards of Light," fill 128 pages of the manual, forming a complete treatise by themselves. The chapter on "Calorimetry and Specific Gravity" is particularly interesting, since it treats of gas as applied to heating and cooking purposes, as a fuel for gas engines, and as a means of imparting incandescence to mantles of the Welsbach type. The author says that "A greater illuminating power is developed in an incandescent burner (Welsbach), properly treated as regards air admixture, with gas of a low calorific power than with gas of a high calorific power." Another fact, perhaps not known to engineers generally, is that Mond gas, which is made from bituminous "slack" and steam, yields 84% of the calorific value of the coal used in making it. The chapter on "The Referee's Test for Sulphur and Ammonia in Gas" is not of particular interest to American readers; but Chapter VI. on "Coal Testing" is good as far as it goes, although too brief to be of much value.

Chapter VII., "Testing Enrichment and Purification Materials," and Chapter VIII., "Purity Tests for Gas in Various Stages of Manufacture," very thoroughly cover the field. Chapter IX., "Testing By-products," and Chapter X., "Technical Gas Analysis," do neither of them go into the details of various methods as a chemist would wish to see in a manual on the subject of gas. This the author excuses by saying that "There are many works devoted to the subject, and it is only proposed here to give a guide to the use of such apparatus as is ordinarily found in gas works." Nevertheless the author does give several complete methods of gas analysis, and it is only to be regretted that he did not go farther into the subject.

The two chapters on meter and governor testing are especially to be commended. It will be seen that this volume would have been better entitled, "A Gas-Testing Manual," for the word analyst implies chemist, whereas the chemistry of gas forms but a very small part of the book, and that part is admittedly not as complete as it should be for a "Gas Analyst's Manual."

A Semi-Popular English Book on the Sanitary Aspects of Water Supplies.

WATER AND ITS PURIFICATION.—A Hand-Book for the Use of Local Authorities, Sanitary Officers, and Others Interested in Water Supply. By Samuel Rideal, D. Sc., Public Analyst for Lewisham District Board of Works. Second Edition, Revised and Extended. London: Crosby, Lockwood & Son. Philadelphia: J. B. Lippincott Co. Cloth; 5 × 9 ins.; pp. 346; tables and 66 illustrations. $3 net.

The first edition of Dr. Rideal's book on the sanitary aspects of water supply appeared about six years ago. In the present edition new matter on water epidemics and sand filtration has been added and the chapter on "Characters of Natural Waters" has been mostly rewritten. As the first edition was not reviewed in Engineering News the latest revision may very properly receive detailed attention here. Nearly a third of the volume is occupied by a consideration of the quality of water, its impurities and the various natural sources of supply. Storage, distribution and purification are next discussed, the latter including a chapter each on central and household filters. A chapter on water softening, and one on analyses and their interpretation, conclude the body of the book. An Appendix contains accounts of a number of typhoid epidemics attributed to water supply, results of a number of analyses of water and sewage, and of boiler incrustations, and other information bearing on the characteristics of water from different sources of supply.

The general plan and scope of the book is similar to Thresh's "Water and Water Supplies." Each book was written primarily for British sanitary authorities and their agents, and the latest revision of each was made at about the same time. Dr. Thresh's work is more comprehensive in plan than Dr. Rideal's, but the latter appears to have made more extensive and satisfactory use of recent American and European authorities. Compared with American books, the one being reviewed is most like Mason's "Water Supply" in the range of topics covered. It contains much more information on household filters and on water softening than Mason gives, but the engineer will find Mason of greater practical value than Rideal, regardless of the fact that one is a British and the other an American book. To Americans the chief value of Dr. Rideal's book, as compared with those written here, will be its British view-point, and the fact that it is fresher than most American books on the sanitary aspects of public water supplies.

Reverting now to special features of Dr. Rideal's book, it is surprising to find, in this twentieth century, four pages devoted to the divining rod and its use in locating underground water supplies. One of these pages is occupied with illustrations of "various forms of divining rods," taken from the Rev. S. Baring Gould's "Curious Myths of the Middle Ages." Dr. Rideal's final remarks on the divining rod are as follows:

> There is no doubt that the employment of a "water-finder" has in a large number of cases led to success, although in numerous cases they have hopelessly failed, and the auditors of the Local Government Board have recently disallowed their fees. If further research should discover a physical law underlying the process, its utility would become more certain and extended.

As an offset to the unfavorable opinion of the author's judgment created by his attitude towards a time-honored delusion, we take pleasure in calling attention to his comments on the studies of public water supplies made by the Massachusetts State Board of Health, as follows:

> It does not seem creditable to England that, while a state like Massachusetts should institute inquiries with such care and in such detail that their results are of benefit to the whole world, our local bodies should often be battling helplessly with problems in such a crudely experimental way as to cost large sums to the ratepayers for abortive schemes which a little more knowledge would have prevented from being undertaken.

We fear that Dr. Rideal has not so fully profited by all the other work of the Massachusetts State Board of Health as might be inferred from the foregoing quotation. Certainly his attitude towards filtration on a large scale did not result from a perusal of the reports of that board, for he speaks in one place of filtered water as "comparatively safe," and in another says that "it is still a common practice to attempt the purification of polluted waters by cumbrous and expensive filter-beds and reservoirs," which he believes is "wrong in theory and commercially wasteful." Again, he concludes his chapter on household filtration by recommending its universal adoption.

Most of the American literature on mechanical filtration appears to have escaped Dr. Rideal's eye, and he has apparently been misled by some of the little that he has seen.

Instead of "being extensively used in America," the Riddell mechanical filter is not even known in this country, unless by a very few investigators of foreign practice. Our wide use of mechanical filters is ascribed by Dr. Rideal to the freezing of open sand filters, but that is only one of several reasons for their use, and does not apply at all in the Southern States, where mechanical filter plans have been installed. Mechanical filters have never been built at Providence, R. I., except on a laboratory scale, and slow-sand filter beds are now under contract.

But notwithstanding these and some less important errors the author has done far better justice to American ideas and practice than have most of his countrymen who have referred to American sanitation.

THE FOUNDATIONS OF GEOMETRY.—By Prof. David Hilbert, University of Göttingen. Translated from the German, by Prof. E. J. Townsend, University of Illinois. Cloth; 5½ × 8 ins.; pp. 132; 52 illustrations. Chicago: Open Court Publishing Co. $1.

This small volume reproduces the substance of lectures on Euclidean geometry at Göttingen, Professor Hilbert builds up the structure of geometry on the basis of the three conceptions—points, lines and planes; these elements he imagines to be entirely independent, except as connected by axioms, which define the elements and describe the different manners of relation between them. The axioms given are arranged in five groups, as axioms treating respectively (1) of connection, (2) of order, (3) of parallels, (4) of congruence, (5) of continuity. It is then shown that the different classes of axioms are entirely independent, which is demonstrated by forming artificial systems of geometry in which a certain group of axioms is assumed not to hold and some other convention is substituted for it; it is shown that the original concepts have a definite meaning in such a geometry, such meaning being definitely fixed by the groups of axioms adopted in that case. The treatment, though strictly logical, is often too compact for anything but a mathematical monograph. The clearness of the English could scarcely be surpassed, and as a translation it is all the more notable.

For the person who has a working knowledge of the practical part of mathematics, such as is the engineer, the principal value of the book lies, we believe, in the suggestion it gives him of another and broader view of geometry than that derived from Euclid; the fact that some amount of study is required in order to get this suggestion in its full value should be considered an advantage.

GENERAL SPECIFICATIONS FOR FOUNDATIONS AND SUBSTRUCTURES OF HIGHWAY AND ELECTRIC RAILWAY BRIDGES.—By Theodore Cooper, M. Am. Soc. C. E., Consulting Engineer. New York: Engineering News Pub. Co. Paper; 6 × 9 ins.; pp. 25; with 13 illustrations. $1.

The well deserved popularity of the author's specifications for highway, electric railway and steam railway bridges has prompted the preparation by him of a set of specifications for the substructure of highway bridges. The specifications are intended to cover ordinary practice in foundation work, and to standardize the proportions and procedure in constructing such work.

Difficult foundations in deep water or those requiring pneumatic or other special appliances or works of such expense as would demand particular study of the conditions to determine the best or most economical solution are excluded from consideration.

The work is in two parts. The first 13 pages contain specifications proper, and the remainder of the work gives a general description of the different classes of substructure and the methods to be adopted in their construction.

In view of Mr. Cooper's reputation as an able and conservative engineer of long experience, it is almost superfluous for us to say that the specifications are thoroughly practical and can be accepted as a safe guide in the construction of the works to which they relate.

MATERIALS OF MACHINES.—By Albert W. Smith, Professor of Mechanical Engineering, Leland Stanford Junior University, Palo Alto, Cal. New York: John Wiley & Sons. Cloth; 5 × 7½ ins.; pp. 142; 17 plates. $1.

The title of this book conceals rather than reveals the nature of its contents. The first chapter, which takes up more than a third of the space of the whole book, gives an admirably lucid outline of the metallurgy of iron and steel. The second chapter is devoted to definitions of words used in describing strength and elasticity. The third chapter treats of cast iron as affected by chemical impurities, mechanical manipulation and temperature. The fourth chapter treats wrought iron and steel in a similar manner.

The fifth chapter touches very briefly on the alloys of copper; and the concluding chapter, also very brief, is on the selection of proper kind of iron or steel to perform various functions in an engine or other machine. The work throughout is noteworthy for the clearness that characterizes the descriptions and theory of processes, the definition of terms, and the reasons assigned for selecting materials to perform given functions; it therefore forms a most excellent elementary text book on the subjects treated.

THE COST OF PRODUCTION.—By Charles J. Watts. The Shaw-Walker Co., Muskegon, Mich. 5½ × 7½ ins.; cloth; pp. 65; 20 illustrations. Cloth, $2; paper, $1.

A method of recording the cost of manufacturing by means of the card system is clearly outlined by the author. While the book is intended primarily for manufacturers, it can be read with profit by engineers, and especially by contractors, who too frequently have no idea of the detailed cost of work. The card system is simple and easy of application to any class of productive work, and its use might be extended with profit in this and other fields.

Pocket Books for Engineers

KENT. Mechanical Engineer's Pocket-Book. 16mo., morocco	$5.00
TRAUTWINE. Civil Engineer's Pocket-Book. 16mo., morocco	5.00
KIDDER. Architect's and Builder's Pocket-Book. 16mo., morocco	4.00
DAWSON. "Engineering" and Electric Traction Pocket-Book. 16mo., morocco	4.00
SEARLES. Field Engineering. 16mo., morocco	3.00
NAGLE. Railroad Engineer's Pocket-Book. 16mo., morocco	3.00
GODWIN. Railroad Engineer's Pocket-Book. 16mo., morocco	2.50
PHILBRICK. Railroad Engineer's Pocket-Book. 16mo., morocco	3.00
WADDELL. De Pontibus (Bridge Engineer's Pocket-Book). 16mo., morocco	3.00
BYRNE. Inspector's Pocket-Book. 16mo., cloth	3.00
BUTTS. Civil Engineer's Field-Book. 16mo., morocco	2.50
MERRIMAN & BROOKS. Surveyor's Hand-Book. 16mo., morocco	2.00
BROOKS. Street Railway Location. 16mo., morocco	1.50
ANDREWS. Hand-Book for Street Railway Engineers. Morocco, 3x5 ins.	1.25

JOHN WILEY & SONS

43 & 45 East 19th Street, New York City

INDUCTION COILS.—How to Make, Use and Repair Them; Including Ruhmkorff, Tesla and Medical Coils, Roentgen Radiography, Wireless Telegraphy and Practical Information on Primary and Secondary Batteries. By H. S. Norrie. Second Edition, revised and enlarged. Cloth; 5 × 6½ ins.; pp. 269; 70 illustrations. New York: Spon & Chamberlain. $1.

There is so little in technical literature on theoretical matters connected with induction coils of the Ruhmkorff type, and so little exact knowledge seems to be extant as to the conditions governing the design of such coils, that one is not disappointed in finding here a book entirely of the "practical" order. The author, whose real name is N. H. Schneider, has compiled a large number of practical hints that may be of aid in building and using induction coils. The first part of the book deals with the matter of construction under the two headings "Coil Construction" and "Contact Breakers"; the text is not exactly a set of directions for the construction of coils, nor a discussion of different detail points that the builder of coils is apt to encounter, but partakes of the nature of both. Different forms of contact breakers are very briefly described in the second chapter, but one is not at all clear, after reading this chapter, under what conditions the different forms are to be used. The author next tells how to "have fun" with induction coils, or how to use them for store window advertising, and under "Gas Lighting" is given a small part of the matter found in the author's book entitled "Electric Gas Lighting." Primary batteries and storage cells are then discussed, but the useful information given might be condensed into a fraction of the space occupied. The book closes with some forty pages on Roentgen rays and wireless telegraphy; this portion could to advantage be entirely omitted from the book.

WORM AND SPIRAL GEARING.—By Frederick A. Halsey, Assoc. Editor "American Machinist." New York: D. Van Nostrand Co. Boards; 3¾ × 5¾ ins.; pp. 85; 23 plates. 50 cts.

This little volume is divided into Part I., Worm Gearing, and Part II., Spiral Gearing. In Part I. the author discusses the efficiency of worm gearing, showing how an increase of pitch angle from the old 5 or 6° worms to the modern 18 to 22° worms has greatly increased efficiency and reduced wear.

In Part II. spiral gears are compared with spur gears, graphical solutions of spiral gear problems are given, and practical conclusions drawn. This volume forms an excellent addition to the Van Nostrand Science Series.

A CLASSIFIED LIST OF MINERALS, PRECIOUS AND OTHER STONES.—By Felix J. Troughton. New York: The Abbey Press. Cloth; 4½ × 7¼ ins.; pp. 27. 50 cents.

The publishers state that "this is the latest, best and most compact list (of minerals) extant," and that "the author has endeavored to include every known mineral and precious stone." We note that mercury, which is occasionally found native, is omitted, and so is malachite. We find that the author has alphabetically listed 539 names of minerals, many of which are synonymous, and this is so small a number that we suspect there are many other omissions. In its present form the book does not possess half the value as a book of reference that it would were the minerals more fully defined. The inclusion of the most characteristic and important properties of each mineral would add little to the size of the book and a great deal to its usefulness. The alphabetical arrangement of the book is wrong in several places.

THE HEALTH OFFICERS' MANUAL AND PUBLIC HEALTH LAW OF THE STATE OF NEW YORK.—Containing the Public Health Law (1893, Chap. 661) and All Statutes Relating to the Public Health, Powers and Duties of Local Boards of Health and Health Officers, Etc., Etc., as Amended to the Close of the Legislative Session of 1902, with Annotations, Forms and Cross-References. By L. L. Boyce. Albany: Matthew Bender. Legal buckram; 6 × 9 ins.; pp. 289. $2.50.

Such a volume as this should be of great value to health boards and their attorneys, and also to many sanitary engineers throughout the State of New York. Outside the State its usefulness will of course be limited, but students of comparative government, and all who undertake to frame health legislation, may find it useful.

MASSACHUSETTS STATE BOARD OF HEALTH.—Report for 1901. Samuel W. Abbott, Secretary; X. H. Goodnough, Engineer. Cloth; 6 × 9 ins.; pp. xlvii + 645; many tables. Boston, Mass.: Address the Board.

A STUDY OF THE STABILITY OF THE EFFLUENTS OF SEWAGE FILTERS OF COARSE MATERIALS.—By H. W. Clark, Chemist of the Massachusetts State Board of Health. Paper; 6 × 9 ins.; pp. 23; tables.

REPORT ON EXPERIMENTAL FILTRATION OF THE WATER SUPPLY OF SPRINGFIELD.—By H. W. Clark. Paper; pp. 47; many tables.

Few public documents are so highly esteemed by engineers and sanitarians throughout the English-speaking world as the annual reports of the Massachusetts State Board of Health. The latest of these reports, just from the press, contains the usual accounts of the advice of the board on local questions of water supply and sewerage, continues the detailed descriptions of the studies of water and sewage purification carried on for some fifteen years at the Lawrence Experiment Station, and also continues the publication of analyses of public water supplies and of polluted rivers. Septic tanks and contact beds, as well as the intermittent filtration of sewage, were studied during the year. A special report, by Mr. Clark, on the stability of sewage effluents from coarse filters operating at high rates, is included in both the main report and a pamphlet reprint, the latter as listed above. The same is true of Mr. Clark's special report on water filtration experiments for the removal of taste and odors from the water stored in the Ludlow reservoir of the waterworks of Springfield. An abstract of and comments on the first of these two special reports were published in Engineering News of Nov. 27, 1902, and an outline of the Springfield experiments and their results appeared in Engineering News for April 17, 1902. These pamphlets were published under a recent legislative act authorizing the expenditure of not over $500 a year for such purposes. They and their probable successors will be welcomed by many engineers and others, both for their handy form, and because they may be expected to aid the Board in meeting the demand for accounts of its special investigations. Heretofore there have not always been a sufficient number of copies of the full report to go around, while at the same time many people have doubtless added bulky volumes to their libraries when a comparatively few pages of the reports was really all they wanted. It may be added here that the present volume is the thinnest issued for a number of years, having a total of 692 pages, against from 774 to 945 in the four preceding reports.

Another special paper in the report for 1901 is devoted to bacterial studies at Lawrence, with special reference to the determination of B. Coli, the commonly accepted index of sewage contamination. This study was prepared by Mr. Stephen De M. Gage, Biologist at the Lawrence Experimental Station.

Some valuable "Staistical Summaries of Diseases and Mortality" are compressed into the comparatively small space of only 35 pages. Elsewhere in the report it is stated that the death rate for the whole state for the year was only 16.82, the lowest previous record for fifty years having been 17 per 1,000 in 1867.

Finally, we may note that early in 1901 the legislature passed an act directing the board to make annual examinations of "all main outlets of sewers and drainage of the cities and towns of the Commonwealth, and the effect of sewage disposal," and to report annually thereon. The first annual report on this subject occupies about five pages of the present volume. We presume that it is shorter than subsequent reports, on account of the brief time allowed to prepare a report for the legislature of 1902. Short as it is, the first of these reports is very interesting and gives promise of much valuable information in the future.

COAL NUMBER OF DE INDISCHE MERCURER (THE INDIAN MERCURY).—By Mr. C. Kraay, Amsterdam: De Indische Mercurer. $1.00.

The weekly journal in question is devoted to the commercial, agricultural, engineering, and mining interests of the Netherlands, and the East and West Indies. This special issue was published on May 31, 1902, in both English and Dutch, and is devoted entirely to coal.

YOU CAN GET

Scientific and Technical Books

from me by mail just as well as if you were in New York yourself.

ALSO

Plotting Paper and other Drawing Materials and Special Stationery

CORPORATIONS AND TECHNICAL SCHOOLS SUPPLIED

FREDERIK A. FERNALD

2982 Broadway, New York

THE TRAGEDY AND COMEDY

IN THE CAREER OF A GREAT RAILROAD

How the Erie's Entire Rolling Stock was Pawned to Pay for Laying the First Rails.

Dan'l Drew's Printing Press, and How it Turned Out Erie Bonds and Stock to Order to be Unloaded on Commodore Vanderbilt.

Dramatic Flight of Jay Gould and Jim Fisk to New Jersey.

The Erie Scandals at Albany.

Arrest of Jay Gould and his Farcical Custody by "Jimmy" Oliver.

The Conversion of Tweed and Tammany to the support of Erie.

The Instantaneous Increase of a Long-Settled Construction Account from $35,000,000 to nearly $90,000,000.

The Murder of Fisk by Ed. Stokes.

Josie Mansfield's Part Therein.

The Amazing Story of "Lord" Gordon-Gordon.

Treachery of the Gould Board of Directors.

Riots at the Grand Opera House. "Tommy" Lynch and Gen. Daniel E. Sickles's part therein.

True Story of the Ousting of Gould from the Control of Erie.

Impeachment of Supreme Court Judges.

How Jay Gould Cancelled an Alleged Erie Shortage of $10,000,000 for Less Than One-Quarter of the Amount, and Made a Million besides by the Rise in Erie Stock due to the Transaction.

Black Friday—The Marine Bank Failure.

How the Stock and Bonded Indebtedness of the Company Grew from $10,000,000 to Over $351,000,000. Is the Load Too Great?

J. P. Morgan & Co. Their Reorganization of the Erie in 1885. A Study in Finance and Economics.

The complete and true story of it all told in Mott's History of the Erie Railroad, entitled "Between the Ocean and the Lakes," 550 pages, 83 fine portraits and engravings. Handsomely bound in cloth, gold edges. Delivered in any part of the world, express charges prepaid, on receipt of price, $7.00. Descriptive circular on application.

How often people say: "I meant to cut that advertisement out, but forgot to do so.

Just the book to buy for a man. DO IT NOW.

ENGINEERING NEWS,
220 Broadway, New York.

You may send to my address as given below, one copy of MOTT'S HISTORY OF THE ERIE RAILROAD, entitled, "Between the Ocean and the Lakes." I will examine it. If I find it to be satisfactory, I will pay the deliverer $7.00. If not entirely satisfactory to me the book is to be returned to you without any cost to me whatever.

Name.....

Address .....

City .....

State .....

ORDERS FOR ANY BOOKS

that are in the market will be promptly filled. A complete catalogue of our own publications and a list of the latest technical publications of other publishers will be sent on request.

THE ENGINEERING NEWS PUBLISHING CO.,
220 Broadway, New York

MOSQUITO EXTERMINATION ON LONG ISLAND.—Report of the North Shore Improvement Association's Experts, Frank E. Lutz and Wm. W. Chambers, for the Summer of 1902. Address Wilmot T. Cox, Secretary, 49 Wall St., New York. Paper; 6 x 9 ins.; pp. 26.

The work done by the two entomologists employed by the association was of an advisory and educative character, to the end that property owners and local boards of health might drain ponds, apply oil thereto, stock them with fish, or take other effective measures towards the extermination of mosquitos.

GROUND WATER.—Being Part IV. of A Soil Study, and Bulletin 72 of The Agricultural Experiment Station of Colorado. By Wm. P. Headden, Chemist to the Station. Fort Collins, Colo.: The Experiment Station. Paper; 6 x 9 ins.; pp. 48; tables.

The observations herein described relate to the variations in the water plane and to the solids in the water. The solids were studied with particular reference to alkali and nitrogenous compounds. They show that "the question of alkalization in Colorado resolves itself into a question of drainage."

THE RIVER-IRRIGATING WATERS OF ARIZONA.—Their Character and Effects. Bulletin 44, Agricultural Experiment Station of Arizona. By R. H. Forbes, Director and Chemist. Tucson, Ariz.: The Experiment Station. Paper; 6 x 9 ins.; pp. 78; tables and illustrations.

These studies relate chiefly to the waters of the Salt, Gila and Colorado Rivers, and include observations of the amounts of salts, sediment and fertilizing matters carried by the streams. It is concluded that the best means of "distributing alkaline accumulations" in irrigated lands "is by flooding," either in connection with crops, like alfalfa, requiring such treatment, or preferably by using fresh river waters for the purpose. Deep irrigation and deep cultivation are also helpful, but "drainage systems will be found necessary to the removal of excessive accumulations of salts in certain districts which are subirrigated by the seepage from higer levels."

WEATHER BUREAU OFFICIALS.—Proceedings of Second Annual Convention, 1901. Edited under the direction of Willis L. Moore, Chief U. S. Weather Bureau, by James Berry, Secretary of the Convention, and W. F. R. Phillips. Washington: U. S. Department of Agriculture. Paper; 6 x 9 ins.; pp. 246; plates, and figures in the text.

There is more of both popular and practical interest in this report than one entirely uninformed as to the nature of the deliberations of weather observers would suppose. Among other topics of special interest to some of our readers may be mentioned cloud studies, accompanied by some handsome photographs taken at high altitudes; discussions regarding the relations of climate to vegetation, animal and human life; river stages and gagings; thermometers, thermographs and automatically recording river gages.

DIGEST OF GOVERNORS' MESSAGES, 1902.—Legislation Bulletin 17, New York State Library. Edited by Robert H. Whitten, Sociology Librarian. Albany, N. Y.: University of the State of New York. Paper: 6 x 9 ins.; pp. 156. 25 cts.

For a number of years past the New York State Library has issued a useful set of bulletins presenting a classified digest or index of State legislation and an occasional bulletin on allied topics. The present bulletin is a classified digest of the messages of the governors of the several states for the year ending April, 1902. Related topics in the President's message are also included. Among other topics in this bulletin are public health, transportation and communication, local government, and labor problems.

SEWAGE PURIFICATION PLANTS.—By J. W. Alvord. Reprinted from the Journal of the Western Society of Engineers for April, 1902. Paper; 6 x 9 ins.; pp. 40. Illustrated. Chicago, Ill.: Address the author, Hartford Building.

A number of plants designed by Mr. Alvord are described and illustrated in this paper. The general subject of sewage purification is also discussed by Mr. Alvord and other members of the society. A later paper by Mr. Alvord, discussing the operation of some of the works described here, was abstracted in Engineering News of Nov. 27, 1902, and will be published in full in the forthcoming Proceedings of the American Society of Municipal Improvements.

The Current Literary Magazines.

The mid-winter holiday numbers of the literary magazines are not expected to contain much matter of the solid sort, such as is commonly reviewed in this column, for purchasers of such magazines at this season of the year do not buy them for scientific or technical contents.

In the December "Century" we find a review of the United States Steel Corporation by Mr. Henry Loomis Nelson. It is a very roseate picture indeed which Mr. Nelson paints of this large corporation and its methods of operation. If the wheels of its internal mechanism all work as smoothly as Mr. Nelson seems to think, it will be a long time before it passes its dividend payments. Another "Century" paper has the modest title, "The Making of the Universe." Its author is Prof. John H. Freese, Astronomical Observer at Harvard University, and he describes in a popular way the latest theories of scientists respecting the process by which nebulous matter in space became condensed to form suns and planets and other bodies. The illustrations are from negatives made at the Harvard Observatory, and are of great interest. The illustrations in this number of "The Century," particularly those in color, surpass even its usual high standard of excellence.

In the Christmas "Harper's" we find a single scientific paper, "The Aztecs of Yesterday and To-day," which should attract any of our readers who are interested in Mexican archæology. Contrary to the prevalent idea that the Aztecs are an extinct race, the author of the article says that there are tribes in Mexico to-day of nearly or quite pure Aztec descent; and he describes their customs and habits.

"The Trade Union and the Superior Workman" is the title of an article in the December "Atlantic" which we heartily commend to employers or managers of labor. The great bulk of current criticism of labor unions and labor union methods at the present time wholly ignores the workman's side of the case, and consequently has no influence whatever toward reforming evils in the unions. If a man would deal successfully with employees in these days he must understand their point of view and the "Atlantic" paper will be distinctly helpful to any employer or manager of labor or to any student of the labor question who reads it with an unprejudiced mind.

In the "Review of Reviews" we find a paper descriptive of the "Ship Combine" or the "International Mercantile Marine Co.," to give it its proper title, and also a good account of the industrial development which has taken place at Sault Ste. Marie.

In the "Captains of Industry" series in the December "Cosmopolitan" we find an interesting biography of Henry Phipps, the man to whom more than any other one perhaps, outside of Mr. Carnegie himself, was due the phenomenal success of the Carnegie enterprises, at least in their early years.

"The World's Work" for December has a profusion of good things of interest to engineers. Among them we may note one of the best descriptions yet published of the great dam at Assouan, a description of the Railway Mail Service and fine full-page portraits of John Fritz and of John B. McDonald, the latter accompanied by a brief biography. This magazine also reprints the notable address of Mr. Frank A. Vanderlip, delivered before the Wilmington Chamber of Commerce. "The World's Work" entitles it "A Conservative Word of Warning," and it certainly deserves the careful study of business men interested in the financial outlook.

The "North American Review" has two papers of special interest to engineers. One by Mr. Cornelius Vanderbilt discusses in a very practical way the application of electricity to steam railway. The other, by Capt. J. M. Palmer, U. S. A., advocates railway construction in our island possessions as the cheapest and most effective aid to military control. The most valuable article in the whole magazine, however, is a paper by Prof. Henry C. Adams, statistician of the Interstate Commerce Commission, entitled "What is Publicity." The paper is written with special reference to the current idea that publicity will prove a cure for trust evils and shows what measures must be taken if

ENGINEERING NEWS

1874 . . . 1903

A Journal of Civil, Mechanical, Electrical and Mining Engineering

PUBLISHED EVERY THURSDAY
AT 220 BROADWAY, NEW YORK

$5.00 A YEAR **TEN WEEKS FOR $1.00**

"A technical journal of character and standing."—Times, New York.

"The best-informed of the engineering fraternity are among its contributors."—Tribune, New York.

"Probably the highest technical authority in journalism."—Eagle, Brooklyn.

"The leading paper in the engineering world."—Herald, Syracuse, N. Y.

"A periodical of the highest character."—Times, Troy, N. Y.

"An independent professional journal."—Observer, Utica, N. Y.

"A technical publication of the first rank."—Sun, Pittsfield, Mass.

"An acknowledged authority."—Tribune, Lawrence, Mass.

"The leading American authority."—Tribune, Scranton, Pa.

"The leading engineering paper in the country."—Press, Cleveland, O.

"The very highest authority in engineering circles."—Herald, Vicksburg, Miss.

"Most reliable and ably edited."—Times, Chattanooga, Tenn.

"One of the greatest and most influential class journals."—Telegraph, Alton, Ill.

"The leading journal of the country on engineering and municipal matters."—Enquirer, Oakland, Cal.

"An authority of the first order."—Tribune Charleston, W. Va.

"The most widely read and popular journal on engineering."—Ledger, Columbus, Ga.

The publishers of Engineering News will spare no effort nor expense to maintain the position accorded to it by the representative journals quoted.

THE MUNICIPAL YEAR BOOK

...1902...

Combines a Directory of Municipal Officials and Franchise Companies, an Exhibit of Municipal and Private Ownership, and an Outline of the Leading Public Works and Services in the 1,524 leading municipalities in the United States.

"Certainly an ideal municipal year book."—Power.

"Municipal boards and committees should find this book of great service."—Review of Reviews.

"Bears the imprint of the care and ability so characteristic of all the products of the Engineering News Pub. Co."—Insurance Engineering.

"The book will be of immense service to engineers and city officials."—Manufacturers' Record.

"The introduction of fifty pages will be found of incalculable value, and gives evidence of the tireless labor that has been expended."—Public Improvements.

"An encyclopedia of municipal news and statistics."—Journal West. Soc. C. E.

Cloth, 6x9 ins. 364 pp. Price, $3.00.

THE ENGINEERING NEWS PUBLISHING COMPANY
220 Broadway, New York

"publicity" is to prove an effectual public safeguard. Prof. Adams speaks from a large experience in this field, and his paper deserves careful study by everyone interested in the problem of trust control.

Turning to the English reviews, we find in the November "Fortnightly" a most interesting paper entitled "The Monroe Doctrine," by Prof. H. Brougham Leech. To any who desire to get a European view of this tenet of American diplomacy, we particularly commend this article. It is not the most pleasant reading to an American, but it is a good thing to take a look at a question from both sides.

The remarkable submarine boat invented by an Italian engineer, Cavaliere Giuseppe Pino, is described in the "Contemporary" for November. The vessel is intended chiefly for recovering treasures from wrecks. The boat is of spherical form, and is used in combination with a "mechanical arm" capable of all the motions of the human arm, and a "hydroscope" by which the area to be worked in is brilliantly illuminated. In the same magazine there is a keen analysis of the Cunard subsidy and the Atlantic shipping combine.

Publications Received.

INSTRUCTION IN MUNICIPAL GOVERNMENT IN AMERICAN EDUCATIONAL INSTITUTIONS.—Committee Report, Presented by Thomas M. Drown, Chairman, at the Boston meeting of The National Municipal League. Philadelphia: National Municipal League. Paper; 6 × 9 ins.; pp. 24.

HARRISBURG'S ADVANCE: A LESSON TO SMALLER MUNICIPALITIES.—By J. Horace MacFarland. Paper; 6 × 9 ins.; pp. 16. Philadelphia: The National Municipal League.

AMERICAN MUNICIPAL PROGRESS.—Chapters in Municipal Socialism. By Charles Zueblin, Professor of Sociology in the University of Chicago. New York: The Macmillan Co. Half leather; 5 × 8 ins.; pp. 380; tables. $1.25 net.

SIMPLE ROOF TRUSSES IN WOOD AND STEEL.—By Malverd A. Howe, M. Am. Soc. C. E., Professor of Civil Engineering, Rose Polytechnic Institute. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 124; illustrated. $2.

THE VALUE OF STREAM GAGINGS.—Suggestions as to the Manner of Applying this Data for the Determination of Power. By John W. Hays, M. Am. Soc. C. E. Broadside; 12 × 20 ins. Reprinted from the "Manufacturers' Record" for Jan. 10, 1901. Address the author, Petersburg, Pa.

AN INTRODUCTION TO THE BACTERIOLOGICAL EXAMINATION OF WATER.—By W. H. Horrocks, Assistant Professor of Military Hygiene, Army Medical School, Netley; Major Royal Army Medical Corps. London: J. & A. Churchill. Cloth; 6 × 9 ins.; pp. 300; 5 plates. $4.20.

TIMBER.—A Comprehensive Study of Wood in All Its Aspects, Commercial and Botanical, showing the Different Applications and Uses of Timbers in Various Trades. Translated from the French of Paul Charpentier, Expert Chemical Engineer, Assayer of the French Mint, etc., by Joseph Kennell. London: Scott, Greenwood & Co. New York: D. Van Nostrand Co. Cloth; 6½ × 10 ins.; pp. 437; tables and 178 illustrations in the text. $6 net.

NATIONAL MUNICIPAL LEAGUE.—Proceedings Eighth Annual Meeting, Boston, May 7 to 9, 1902. Clinton Rogers Woodruff, Editor. Philadelphia: National Municipal League. Cloth; 6 × 9 ins.; pp. 357. $1.

STATISTICS OF CITIES.—Bulletin 42, U. S. Department of Labor, Carroll D. Wright, Editor. Washington, D. C.: Department of Labor. Paper; 6 × 9 ins.; pp. 170; many tables.

THE WEALTH AND PROGRESS OF NEW SOUTH WALES, 1900-01. By T. A. Coghlan, Hon. F. S. S., Statistician New South Wales. Thirteenth issue. Sydney, N. S. W. Boards; 5½ × 8½ ins.; pp. 1,043; map.

FRICTION HEAD DIAGRAMS FOR FLOW OF WATER IN CLEAN IRON PIPES.—By Prof. I. P. Church. Paper; 6 × 9 ins.; pp. 4. Ithaca, N. Y.: Address the author.

THE AMERICAN SYREN AND SHIPPING.—An illustrated weekly devoted to marine shipping. Published at 313-5 Maritime Bldg., New York City. Annual subscription, $5.

BEITRAG ZUR KENNTNISS DES SOGENANNTEN BIOLOGISCHEN VERFAHRENS, insbesondere die bei der Herstellung und dem Betriebe biologischer Abwässerungsanlagen zu beachtenden allgemeinen Gesichtspunkte. By Dr. K. Thumm. Paper, 6 × 9 ins.; pp. 31. Berlin, 1902.

AN ENGLISH ADDRESS ON MUNICIPAL ENGINEERING.—Presented to the Conference of Municipal and County Engineers and Other Sanitary Authorities at Manchester, England, September, 1902, by Chas. Jones, M. Inst. C. E., President of Section G of the Congress of the Sanitary Institute of Great Britain. Paper; 5 x 7 ins.; pp. 16. Address the author, Ealing, England.

THE MICROSCOPE IN THE DIAGNOSIS OF SCARLET FEVER.—By W. K. Jaques, Director of the Laboratory of the Chicago Health Department. Paper; 6 × 9 ins.; pp. 10. Chicago: Address the author.

RAILWAY TRACK.—By A. Haarmann, General Director of the Georgs-Marien Bergwerks und Huetten Vereins. Third volume. Leipzig: Wilhelm Engelmann. Cloth; 4to; pp. 277; 503 illustrations.

LE CIMENT ARME ET LES APPLICATIONS.—By Marie-Auguste Morel. Paris: Gauthier-Villars and Masson et Cie. Paper; 4½ × 7½ ins.; pp. 152; illustrated.

L'INDUSTRIE DES RESINS.—Par Edmond Rabate. Paris: Gauthier-Villars. Paper; 4¾ × 7½ ins; pp. 180; illustrated.

A MANUAL OF DRAWING.—By C. E. Coolidge, Assistant Professor of Machine Design, Sibley College, Cornell University. New York: John Wiley & Sons. Paper; 6 × 9 ins.; pp. 172; illustrated. $1.

STEREOTOMY.—By Arthur W. French, Professor of Civil Engineering, Worcester Polytechnic Institute, and Howard C. Ives, Instructor in Civil Engineering, Worcester Polytechnic Institute. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 115; illustrated. $2.50.

AMERICAN STREET RAILWAY ASSOCIATION.—Report of the Detroit Meeting, 1902. T. C. Pennington, Secretary, 2020 State St., Chicago. Paper; 6 × 9 ins.; pp. 343; illustrated.

ANCIENT AND MODERN ENGINEERING AND THE ISTHMIAN CANAL.—By Wm. H. Burr, M. Am. Soc. C. E., Professor of Civil Engineering in Columbia University. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 473; tables and illustrations. $3.50 net; postage 27 cts.

ALTERNATING-CURRENT MACHINES.—Being the Second Volume of Dynamo Electric Machinery; Its Construction, Design, and Operation. By Samuel Sheldon, M. Inst. E. E., and Hobart Mason, Assoc. Am. Inst. E. E. New York: D. Van Nostrand Co. Cloth; 5½ × 8 ins.; pp. 251; 184 illustrations. $2.50 net.

ARMATURE WINDINGS OF DIRECT-CURRENT DYNAMOS.—By E. Arnold, Translated from the German by Francis B. De Gress. Cloth; 6 × 9 ins.; pp. 124; 146 illustrations. $2.

BIRDS OF WYOMING.—Bulletin 55. Wyoming Experiment Station. By Wilbur C. Knight, Geologist to the Station, Laramie, Wyo. Director Experiment Station. Paper; 6 × 9 ins.; pp. 174; plates and figures in the text.

CIVIL ENGINEER'S POCKET-BOOK.—By John C. Trautwine, C. E. Revised by John C. Trautwine, Jr., and John C. Trautwine, 3d, Civil Engineers. New York: John Wiley & Sons. Leather; 4½ × 6¾ ins.; pp. xxxii. + 1,079; many tables and illustrations. $5.

ELECTRIC AND MAGNETIC CALCULATIONS.—For the Use of Electrical Engineers and Artisans, Teachers, Students, etc. By A. A. Atkinson, Professor of Physics and Electricity in Ohio University, Athens, O. New York: D. Van Nostrand Co. Cloth; 5½ × 7 ins.; pp. 310; illustrated. $1.50 net.

ELECTRICAL CATECHISM.—An Introductory Treatise on Electricity and Its Uses. By Geo. D. Shepardson, M. E., Professor of Electrical Engineering in the University of Minnesota. New York: American Electrician Co. Cloth; 7 × 10 ins.; pp. 403; illustrated. $2.

ELECTRICAL TESTING IN PHYSICS AND ELECTRICAL ENGINEERING.—Being a Course suitable for First and Second-Year Students and Others. By G. D. Aspinall Parr, Assoc. M. Inst. E. E. London and New York: Longmans, Green & Co. Cloth; 6 × 9 ins.; pp. 392; 231 illustrations. $2.50.

ELEMENTARY TREATISE ON ALTERNATING CURRENTS.—By W. G. Rhodes, M. Inst. E. E. London and New York: Longmans, Green & Co. Cloth; 6 × 9 ins.; pp. 211; 83 illustrations. $2.60.

FRENCH ARCHITECTURE IN THE FIRST HALF OF THE EIGHTEENTH CENTURY.—By Russell Sturgis, F. Am. Inst. Arch. With a Drawing by D. N. B. Sturgis and Fourteen Photographic Plates. Rochester, N. Y.: Cutler Manufacturing Co. Paper; 10 × 13 ins.; pp. 23.

GALVANIC BATTERIES.—Their Theory, Construction and Use, Comprising Primary, Single and Double Fluid Cells, Secondary and Gas Batteries. By S. R. Bottone. London and New York: Whittaker & Co. Cloth; 5 × 7 ins.; pp. 376; 144 illustrations. $1.50.

LOCOMOTIVE MECHANISM AND ENGINEERING.—By H. C. Reagan. New York: John Wiley & Sons. Cloth; 5 × 7½ ins.; pp. 578; illustrated. $2.

MILK IN RELATION TO PUBLIC HEALTH.—The Necessity for the Enactment of Senate Bill Entitled "A Bill to Regulate the Production and Sale of Milk and Cream in and for the District of Columbia." Senate Document 441. By Geo. M. Kober, M. D., Chairman of the Committee on Legislation, Medical Society of the District of Columbia. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.; pp. 235; tables and 15 plates.

ROGER DRAKE, CAPTAIN OF INDUSTRY.—By Henry Kitchell Webster, Author of the "Banker and the Bear." New York: The Macmillan Co. Cloth; 6 × 9 ins.; pp. 306; 17 illustrations. $1.50.

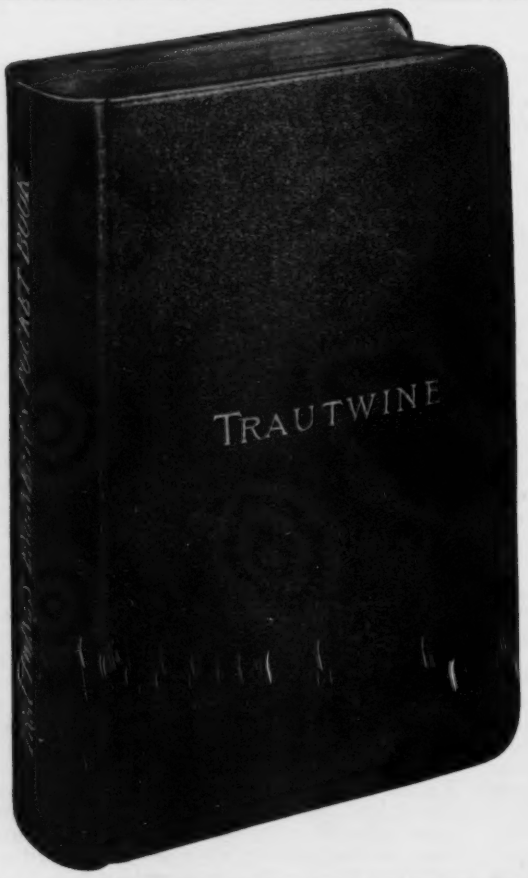
SEWAGE POLLUTION IN THE METROPOLITAN AREA NEAR NEW YORK CITY AND ITS EFFECT ON INLAND WATER RESOURCES.—Water Supply and Irrigation Paper 72. By Marshall Ora Leighton. Paper; 6 × 9 ins.; pp. 75; 8 plates and 4 illustrations in the text. Washington, D. C.: U. S. Geological Survey.

TRADES WASTE: ITS TREATMENT AND UTILIZATION.—With Special Reference to the Prevention of Rivers Pollution. By W. Naylor, Assoc. M. Inst. C. E., Chief Inspector of Rivers, Ribble Joint Committee. London: Chas. Griffin & Co. Philadelphia: J. B. Lippincott Co. Cloth; 7 × 9 ins.; pp. 267; tables, 48 plates, and many illustrations in the text.

LETTERS AND LETTERING.—A Treatise with 200 Examples. By Frank Chateau Brown. Boston: Bates & Guild Co. Cloth; 6 × 9 ins.; pp. 214; 211 illustrations. $2.

Trautwine's Civil Engineer's Pocket Book

New (18th) Edition; 70th Thousand; 1902



370 Pages of New Matter

including digest of specifications for bridges and buildings and for iron and steel, conversion table of units of measurement, price-list and business directory of manufactured articles, bibliography, trusses, statics, strength of beams, cement, concrete, etc.

JOHN WILEY & SONS
43 East 19th Street
New York

ctory Treatise
D. Stevenson,
neering in the
American Elec-
illustrated. $2.

AND ELEC-
Course. Durable
nd Other By
E. E. London
o. Cloth; 6 x 9

NATING CUR-
E. E. London
Co. Cloth; 6 x

RST HALF OF
Russell Sturgis.
by D. N. B.
tes. Rochester,
r; 10 x 13 ins.;

, Construction
e and Double
ries. By S. R.
hittaker & Co.
ations. $1.50.

NEERING.—By
& Sons. Cloth;

TH.—The Neces-
ill Entitled "A
ale of Milk and
umbia." Senate
I. D., Chairman
dical Society of
on, D. C.: Pub.
s and 15 plates.

TRY.—By Henry
Banker and the
o. Cloth; 6 x 9

POLITAN AREA
EFFECT ON 'N-
Supply and Ir-
eighton. Paper;
ustrations in the
ogical Survey.

AND UTILIZA-
he Prevention of
e. M. Inst. C. E.,
Joint Committee.
lphia: J. B. Lip-
267; tables, 48
text.

ise with 200 Ex-
Boston: Bates &
14; 211 illustra-

Book

of

f speci-
es and
r iron
version
easure-
d busi-
manu-
biblio-
statics,
ms, ce-
tc.

& SONS
Street